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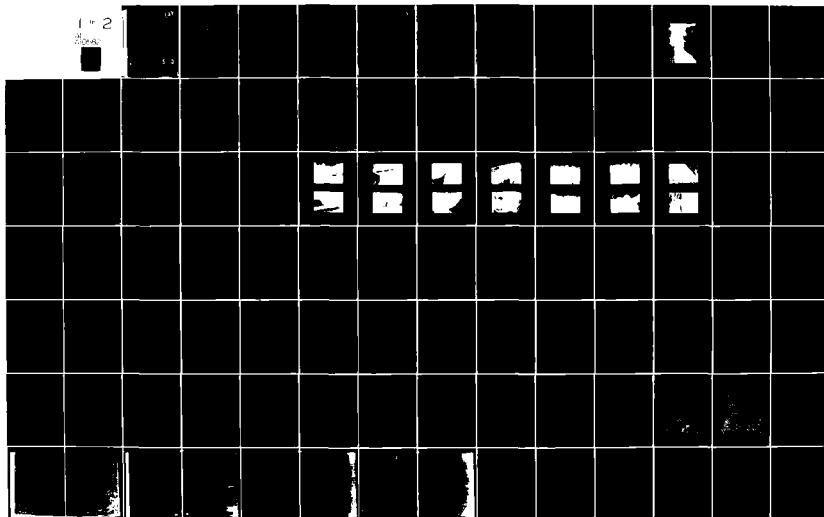
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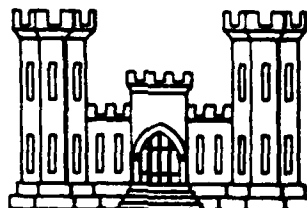
LEVEL II
LOWER HUDSON RIVER BASIN



GLENHAM DAM

DUTCHESS COUNTY, NEW YORK
INVENTORY NO. N.Y. 72

PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Examination of available documents and visual inspec- tion of the dam and appurtenant structures did not reveal any conditions which constitute an immediate hazard to human life or property.			

Using the Corps of Engineers' screening criteria, it has been determined that the dam would be overtopped for all storms exceeding 33 percent of the Probable Maximum Flood (PMF). Therefore, the spillway is adjudged as "seriously inadequate," and the dam is assessed as "unsafe, non-emergency."

Structural stability analyses based on available information, indicate that factors of safety against overturning are generally low, and the locations of the resultants fall outside of the middle 1/3. The factor of safety against sliding was less than the recommended value of 3 for Cases 3 and 4. Therefore, when the dam is subjected to severe loading conditions such as a 1/2 PMF or PMF event, the factors of safety fall to below critical levels.

It is therefore recommended that, within three months of notification of the owner, detailed hydrologic and hydraulic investigations of the structure should be undertaken to more accurately determine the site-specific characteristics of the watershed and their effects upon the overtopping potential of the dam. At the same time, further analyses of the structural stability of the dam should be performed. Also, an in-depth study of the seepage and its effect on the masonry work of the dam must be performed. The results of these investigations and analyses will determine the appropriate remedial measures required. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Also, around-the-clock surveillance must be provided during these periods.

The regular inspections and maintenance procedures currently conducted by the owner's representative are inadequate. A thorough checklist should be compiled by the owner's representative and completed during each inspection. Maintenance items should be completed annually.

Monitor the seeps in the dam at regular intervals and during periods of high reservoir levels for turbidity or increase in flow.

The following remedial measures must be completed within one year:

1. Point the joints between bricks on the right spillway training walls.
2. Repair the deteriorated concrete on the downstream side of the right wall of the dam.
3. Replace the concrete facing around the 4.5-foot diameter outlet conduit.
4. Repair the outlet pipe valve.
5. Repair the spalled and deteriorated concrete surface on the crest of the right side of the dam.

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
GLENHAM DAM
I.D. No. NY 72
DEC DAM No. 212C-553, LOWER HUDSON RIVER BASIN
DUTCHESS COUNTY, NEW YORK

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Glenham Dam (I.D. No. NY 72)
State: New York
County: Dutchess County
Stream: Fishkill Creek
Date of Inspection: 8 March 1981

ASSESSMENT

Examination of available documents and visual inspection of the dam and appurtenant structures did not reveal any conditions which constitute an immediate hazard to human life or property.

Using the Corps of Engineers' screening criteria, it has been determined that the dam would be overtopped for all storms exceeding 33 percent of the Probable Maximum Flood (PMF). Therefore, the spillway is adjudged as "seriously inadequate," and the dam is assessed as "unsafe, non-emergency."

Structural stability analyses based on available information, indicate that factors of safety against overturning are generally low, and the locations of the resultants fall outside of the middle 1/3. The factor of safety against sliding was less than the recommended value of 3 for Cases 3 and 4. Therefore, when the dam is subjected to severe loading conditions such as a 1/2 PMF or PMF event, the factors of safety fall to below critical levels.

It is therefore recommended that, within three months of notification of the owner, detailed hydrologic and hydraulic investigations of the structure should be undertaken to more accurately determine the site-specific characteristics of the watershed and their effects upon the overtopping potential of the dam. At the same time, further analyses of the structural stability of the dam should be performed. Also, an in-depth study of the seepage and its effect on the brickwork of the dam must be performed. The results of these investigations and analyses will determine the appropriate remedial measures required. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Also, around-the-clock surveillance must be provided during these periods.

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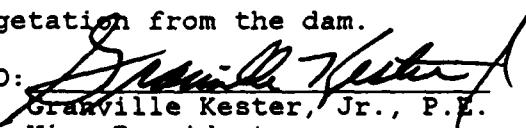
The regular inspections and maintenance procedures presently conducted by the owner's representative are inadequate. A thorough checklist should be compiled by the owner's representative and completed during each inspection. Maintenance items should be completed annually.

Monitor the seeps in the dam at regular intervals and during periods of high reservoir levels for turbidity or increase in flow.

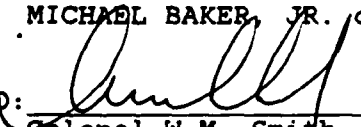
The following remedial measures must be completed within one year:

1. Point the joints between bricks on the right spillway training walls.
2. Repair the deteriorated concrete on the downstream side of the right wall of the dam.
3. Replace the concrete facing around the 4.5-foot diameter outlet conduit.
4. Repair the outlet pipe valve.
5. Repair the spalled and deteriorated concrete surface on the crest of the right side of the dam.
6. Repair all spalled areas on the concrete surfaces of the dam.
7. Remove all vegetation from the dam.

SUBMITTED:


Granville Kester, Jr., P.E.
Vice President
MICHAEL BAKER, JR. of New York, INC.

APPROVED:


Colonel W.M. Smith, Jr.
New York District Engineer

DATE:

14 Aug 81



Overall View of Dam
Glenham Dam
I.D. No. NY 72
8 March 1981

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
GLENHAM DAM
I.D. No. NY 72
DEC DAM No. 212C-553
LOWER HUDSON RIVER BASIN
DUTCHESS COUNTY, NEW YORK

SECTION 1: PROJECT INFORMATION

1.1 GENERAL

- a. Authority - The Phase I Inspection reported herein was authorized by the Department of the Army, New York District, Corps of Engineers, to fulfill the requirements of the National Dam Inspection Act, Public Law 92-367.
- b. Purpose of Inspection - This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam - Glenham Dam is a concrete gravity structure 44.9 feet high and 312 feet long. The dam is "L"-shaped. The spillway crest is perpendicular to the concrete structure that comprises the right¹ side of the dam. The right side of the dam is a complex concrete structure 200 feet long with a crest width varying from 8.5 feet to 24 feet. The dam rises 27 feet above the ground surface of the right abutment with a set of concrete steps providing access to the top of dam. Some of the horizontal and sloping surfaces are capped with pre-cut stone slabs. The concrete on some sections of the lower half of the dam has deteriorated revealing a brick wall about 8 inches behind the concrete surface. The training walls above the downstream face of the spillway are made of large cut stone and a section of brick wall.

¹Looking downstream.

The spillway is an ogee-shaped concrete weir 140 feet long (measured perpendicular to flow). The spillway has a rounded crest, a near vertical upstream face, and a downstream face with a slope of 1H:1V (Horizontal to Vertical). The left spillway training wall is formed by the left abutment's vertical rock face. The 11-foot high vertical concrete face of the dam forms the right training wall. The spillway discharges into a stilling basin which is 140 feet wide and 65 feet long. This basin is bound by the steep rock face of the left abutment and a 2-foot thick concrete training wall on the right side. At the downstream end of the stilling basin, water discharges over a 1-foot wide and 3-foot high rounded concrete end sill into the natural river channel.

There are four control valves on the crest of the dam. Three of these valves are located beside one another in a line near the center of the right half of the dam. These three valves control the water flow to Beacon Textile Printers, Ltd. The fourth valve is closer to the spillway crest and controls the valve on the 4.5-foot diameter brick-lined conduit that runs through the structure and discharges at the toe of the dam.

- b. Location - Glenham Dam is located on Fishkill Creek, approximately 4200 feet northeast of Beacon, New York. The dam is located in Dutchess County, New York. The coordinates for the dam are N 41° 30.8' and W 73° 56.7'. The dam can be found on the Wappingers Falls, New York, USGS 7.5 minute topographic quadrangle. A location plan is included in this report in Appendix E.
- c. Size Classification - Glenham Dam is 44.9 feet high and the reservoir storage capacity at the crest of the dam (elevation 189.6 feet M.S.L.) is 43 acre-feet. Therefore, the dam is in the "intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams (Reference 13, Appendix D).
- d. Hazard Classification - A factory, Beacon Textile Printers Ltd., is located about 100 feet downstream of the dam, on the right side of the downstream channel. Loss of life in this factory is likely if the dam were to fail. Glenham dam is, therefore, considered in the "high" hazard category, as defined by the Recommended Guidelines for Safety Inspection of Dams.

- e. Ownership - The dam is owned and operated by Beacon Texile Printers Ltd., Mill and Front Street, Beacon, New York 12508. The contact person is Lineo Fernandez (telephone 914-831-1300).
- f. Purpose of Dam - Glenham Dam is used as the water source for Beacon Texile Printers Ltd.
- g. Design and Construction History - The dam was originally built around 1875, but the original builders and designers are unknown. The dam was reconstructed in 1911-1915. These alterations were engineered by Fred D. Rhodes and Edward N. Friedman. The architects were Freedman, Robertson and Keeler of New York City, and the construction work was done by Murphy Bros. of New York City.
- h. Normal Operating Procedures - The reservoir level is normally maintained near the crest of the spillway. However, according to Beacon Texile Printer's Chief of Maintenance, the reservoir level sometimes drops as much as 9 feet below the crest of the dam during dry summers. The dam is visually inspected each month. The three valves controlling the water flow to the factory are in good condition and are operated every three or four months, according to the Chief of Maintenance. The fourth valve, on the crest of the dam, controls the 4.5-foot diameter outlet pipe at the toe of the dam. This valve was partially opened at the time of inspection; it reportedly cannot be entirely closed, but it can be opened. There is no operating schedule or maintenance program for this dam.

1.3 PERTINENT DATA

- a. Drainage Area (square miles) - 188.57
- b. Discharge at Dam (c.f.s.) -

Spillway Capacity (at Minimum Top of Dam Elev. 169.6 ft. M.S.L.) ²	19,761.0
Reservoir Drain at Normal Pool	342.0

²All elevations are referenced to the spillway crest, elev. 159.0 ft. M.S.L. estimated from the USGS 7.5 minute topographic quadrangle, Wappingers Falls, New York.

c. Elevation (Feet Above M.S.L.) -

Minimum Top of Dam	169.6
Normal Pool (Spillway Crest)	159.0
Streambed at Toe of Dam	124.7

d. Reservoir Surface (Acres) -

Top of Dam (Elev. 169.6 ft. M.S.L.)	1.90
Spillway Crest (Elev. 159.0 ft. M.S.L.)	1.45

e. Reservoir Storage Capacity (Acre-Feet) -

Top of Dam (Elev. 169.6 ft. M.S.L.)	43.0
Spillway Crest (Elev. 159.0 ft. M.S.L.)	25.0

f. Dam -

Type: Concrete gravity	
Length (Feet)	312.0
Height (Feet)	44.9
Top Width (Feet)	8.5 to 24.0
Side Slopes - Upstream	Vertical
Downstream	Vertical to 1H:1V

Cut-off: None - according to design plans, the dam is built on hardpan and rock.

g. Spillway -

Type: Concrete ogee-shaped weir	
Crest Length Perpendicular to Flow (Feet)	140.0
Crest Width Parallel to Flow (Feet)	6.5
Crest Elevation (ft. M.S.L.)	159.0

h. Reservoir Drain

Type: A 4.5-foot diameter brick-lined conduit that extends from the upstream face to the toe of the dam.

Control: A gate valve operated from the crest of the dam is used to control flow through this pipe.

SECTION 2: ENGINEERING DATA

2.1 GEOLOGY

Glenham Dam is located in the southeastern section of the "Appalachian Uplands" physiographic province of New York State. This province is geologically complex and characteristically composed of a diverse group of sedimentary metamorphic and igneous rocks which have been tectonically disturbed by normal and thrust faulting.

Bedrock in the immediate vicinity of the dam is represented by sedimentary and metamorphic rocks of Ordovician, Cambrian, and Precambrian age. The Ordovician rocks are composed of the Mount Merino and Indian River Formation, a shale; the Austin Glen Formation, a shale and graywacke; the Walloonsac Formation, a phyllite schist and metagraywacke; and the Balmville Limestone. Cambrian exposures consist of the Poughuag Quartzite and Precambrian exposures consist of a hornblende gneiss. The Precambrian hornblende gneiss has been thrust over the Ordovician Austin Glen and Indian River Formations. To the southeast of the thrust fault, a large normal fault has developed in the hornblende gneiss. Between the thrust fault and normal fault, the hornblende gneiss has been covered by a thin veneer of Quaternary glacial till. Within the area defined by the glacial till remnants of the Balmville Limestone and Walloonsac Formation have been identified. The only exposure of the Poughuag Quartzite is along the normal fault within the hornblende gneiss, suggesting it is a quartz vein filling which has formed along the fault plain. Both faults occur within 2 miles of the lake.

2.2 SUBSURFACE INVESTIGATION

Detailed subsurface information was unavailable for consideration as part of this investigation. A letter dated 1 November 1911 states "the dam rests partly on rock and partly on hard-pan." This, however, was conjecture on the part of the writer, based on discussion with two men who helped build the dam in 1875. A rock outcrop located at the right abutment consisted of hornblende granite to granitic gneiss. The left abutment rock outcrop is a complex formation of quartzite and limestone with overlying glacially derived soils. This soil is identified in the soils report for Dutchess County (prepared by the Soil Conservation Service) as Troy gravelly loam. The soils on the right abutment are man-made fills.

2.3 DAM AND APPURTENANT STRUCTURES

The original plans for this dam were unavailable. However, plans by Fred D. Rhodes and Edward N. Friedman showing the alterations made to the dam between 1911-15 when the dam was raised 7 feet were available for review and included in Appendix E.

The dam is used as a water supply for the adjacent factory. The dam is an "L"-shaped concrete gravity structure with a 140-foot wide ogee-shaped spillway with a vertical upstream face and a downstream face with a slope of 1H:1V (Horizontal to Vertical). The spillway discharges into a 65-foot long stilling basin with its left side being the rock from the left abutment; the right side is a concrete training wall. At the downstream end of the stilling basin, the water flows over a rounded concrete berm into the natural river channel. The right side of the dam, parallel to the flow, is a complex concrete structure 27 feet above the natural ground.

Three control valves are on the crest near the center of the right side of the dam. These three valves control the flow of water to the adjacent factory. A fourth control valve is located on the crest near the spillway to control the flow from the 5-foot diameter outlet pipe at the toe of the dam.

2.4 CONSTRUCTION RECORDS

No records are available for the original construction of the dam. A letter dated 1 November 1911 from Fred D. Rhodes, Consulting Engineer, to the State of New York Conservation Commission states that the dam is founded partly on rock and partly on hard-pan. The letter further explains the proposed steps to be followed during the raising of the dam. This letter is included in Appendix G. No other construction records were available for this investigation.

2.5 OPERATING RECORDS

No operating records are maintained by the owner. However, according to the Chief of Maintenance, the dam is visually inspected monthly, and the control valves are operated periodically.

2.6 EVALUATION OF DATA

The background information collected during this investigation was obtained primarily from files of the New York

State Department of Environmental Conservation. Supplementary information was acquired through conversations with Mr. Rino Furlani, Chief of Maintenance, Beacon Textile Printers, Ltd. The available data are considered adequate and reliable for Phase I Inspection purposes.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

- a. General - The visual inspection of Glenham Dam was conducted on 8 March 1981. The weather was cloudy with temperatures around 35° F. At the time of inspection, the reservoir level was at 180.0 feet M.S.L. Deficiencies found during the inspection will require remedial measures. A Field Sketch of conditions found during the inspection is included in Appendix E. The complete Visual Inspection Checklist is presented as Appendix B.
- b. Spillway - The spillway makes up the left side of the dam. It extends 140 feet from the left abutment across the river and connects to the right side of the dam which is perpendicular to the spillway crest. The spillway is an ogee-shaped concrete weir with a near-vertical upstream face, a rounded crest, and a downstream face with a slope of 45°. Approximately 1.0 foot of water was flowing over the crest at the time of inspection, making observation difficult. There were no major cracks observed. The spillway is bound by a near-vertical stone face on the left side, and there appeared to be no major problem at the left side of the spillway. The right side of the spillway is bound by the vertical face of the right side of the dam. This face forms a concrete wall above the crest of the dam, and the portion of the wall above the downstream slope is made of brick and stone. The concrete above the crest is spalling, and the mortar has been washed away from some of the joints of the brick and stone wall above the downstream side of the spillway. Grass is growing in some of the joints near the downstream side of the spillway.

The spillway discharges into a stilling basin which is 140 feet long and extends 65 feet beyond the toe of the dam. The water discharges over a 1-foot wide and 3-foot high rounded concrete end sill. There appeared to be no major problems with the stilling basin; however, the water was 3.5 feet deep at the time of inspection, making visual observation difficult.

- c. Dam - The right side of the dam is a concrete structure about 200 feet long with a height of 44.9 feet. Due to the complex shape of this side,

the crest width varies from 8.5 feet to 25 feet (see Appendix E - Field Sketch). The dam is made up of three different horizontal levels. The first (and top) level of the dam is capped by a deteriorated and spalled concrete surface. However, the concrete near the valve controls appears to be in good condition with no signs of spalling. At two places on the dam, there is a second horizontal level about 10 feet below the crest. This second level varies in width from 7.5 feet to 18 feet. This level is capped by rectangular-shaped pre-cut stone slabs about 4 inches thick. The third and lowest level of the dam is about 16 feet below the second level. This level is located at the base of the dam about 14 feet above the water level of the stilling basin. The bottom level is capped by pre-cut stone slabs. At the downstream end of the dam, the second and third levels are connected by a 45° sloping wall, also capped by pre-cut stone slabs. Nearly all of the joints between these stone slabs are overgrown with grass, weeds, brush and a few small trees. The side of the dam toward the reservoir is a vertical concrete surface that has been entirely spalled. The outside of the dam varied from a vertical to a 1H:5V (Horizontal to Vertical) slope. The majority of this surface was also spalled. In some places, the outer concrete layer had completely deteriorated, revealing a brick wall about 6 inches to 8 inches behind the former concrete surface. There is a clinging vine growing on the dam's concrete surface. This vine covers about 50% of the concrete surface.

Six seeps are located near the base of the dam (see Appendix E - Field Sketch). The seeps were all flowing clear with no signs of turbidity at the time of inspection. The estimated rate of flow of these seeps varied between 0.5 and 1.0 gpm (gallons per minute). A plywood box has been built around one of these seeps. This box apparently collects the water and discharges it through a pipe to the toe of the dam.

- d. Outlet Works - Four control valves are located on the crest of the dam. Three control flows to the factory and one controls a 4.5-foot diameter outlet pipe. Two of these valves, the partially opened valve for the 4.5-foot diameter outlet pipe and the opened valve supplying water to the factory, appeared to have been recently greased. According to the Chief of Maintenance, all four valves are

operable with the exception of the valve on the main outlet pipe that cannot be entirely closed. The top part of the iron grating that makes up the trash rack over the three outlet pipes for the factory appeared to be in good condition.

It appeared that the outer 8-inch layer of concrete facing has washed away from the outlet area of the 5-foot diameter conduit, revealing a cut-stone wall. There was little or no mortar between the joints of these stones. Behind this stone wall was the brick-lined 5-foot diameter conduit. An I-beam was laying across the outlet of this conduit and could partially obstruct the conduit when the flow through the pipe reaches or exceeds a depth of 18 inches.

- e. Downstream Channel - The downstream channel below the stilling basin is a natural river channel about 120 feet wide and lined by a cut-stone vertical river wall about 8 feet high on the right side and a natural slope on the left side. The outlet conduit discharges into a separate side channel about 15 feet wide that is bound by the cut-stone river wall on the right side and by a 2-foot thick concrete wall separating the channel from the stilling basin on the left side. This concrete wall ends about 100 feet below the outlet of the pipe where the side channel joins the natural river channel.

A factory, Beacon Textile Printers Ltd., is located about 100 feet downstream of the dam on the right side of the downstream channel and just above the river wall.

- f. Reservoir - The slopes adjacent to the reservoir, are mostly bare rock outcroppings. There were no signs of instability, and sedimentation was not reported to be a problem.

3.2 EVALUATION

The visual inspection revealed several deficiencies in this structure. The following items were noted:

1. Six seeps (from approximately 0.5 to 1.0 gpm) are located near the base of the dam.
2. The right spillway training wall has some of the mortar washed out from between the bricks.

3. On the downstream side of the right wall, the concrete has deteriorated to show the brick core.
4. The concrete facing has washed away from the outlet area of the 5-foot diameter conduit.
5. An I-beam is laying across the outlet end of the 5-foot diameter outlet pipe.
6. The 5-foot diameter outlet pipe valve cannot be entirely closed.
7. The crest on the right side of the dam has a spalled and deteriorated surface.
8. Almost all of the dam's concrete surface is spalled and deteriorated.
9. Trees and grass are growing in the joints of the cut stones on the crest of the dam.
10. A clinging vine covers 50 percent of the concrete surface.

SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There are no formal written instructions for operating the reservoir. The normal water surface elevation is near the spillway crest elevation of 159.0 feet M.S.L. Water can be released to the downstream area through a 5-foot diameter brick-lined conduit; however, the valve controlling this conduit, operated from the crest of the dam, cannot be entirely closed. There are three other valves on the crest of the dam that control the water flow to the Beacon Textile Printers Ltd. factory.

4.2 MAINTENANCE OF DAM

Maintenance of the dam is the responsibility of Beacon Textile Printers, Ltd. The maintenance of the dam is considered inadequate, as evidenced by the general deterioration of the dam. The Chief of Maintenance inspects the dam about every month. The three valves that control the flow of water to the factory are operated every three or four months.

4.3 WARNING SYSTEM

At the time of the inspection, there was no warning system or emergency action plan in operation.

4.4 EVALUATION

Past maintenance of the dam and operating facilities appears to have been inadequate. A checklist should be compiled by the owner's representative to document the findings made during the periodic inspections and the maintenance items completed. A warning system and emergency action plan should be developed and put into operation.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 DRAINAGE AREA CHARACTERISTICS

The drainage area consists of gentle-to-moderate slopes well covered by forests and ground vegetation. Some upland storage exists in the form of flat and swampy areas and small lakes. The total drainage area is 188.57 square miles.

5.2 ANALYSIS CRITERIA

The hydraulic capacity of the dam, reservoir, and spillway was assessed by utilizing the U.S. Army Corps of Engineers Flood Hydrograph Package HEC-1 DB. The hydrologic characteristics of the basin, specifically the Snyder's Unit Hydrograph Parameters, were average values derived from the Hydrologic Flood Routing Model for Lower Hudson River Basin, Fishkill Creek (Reference 14, Appendix D). The runoff hydrograph was developed by simulating the Standard Project Storm (SPS). Total SPS rainfall and excess were used to approximate the SPS flow at the USGS gage number 3735 at Beacon, New York of 26,207 c.f.s. This gage is 1300 feet downstream from Glenham Dam. Using $t_p = 10.0$ hr., $C_p = 0.44$, initial rainfall loss of 3.5 in., and a constant loss rate of 0.45 in./hr., a flow of 28,535 c.f.s. was obtained. This flow is 8 percent of that calculated in Hydrologic Flood Routing Model for Lower Hudson River Basin, Fishkill Creek for this gage. The PMP rainfall amounts were then substituted for the SPS amounts. The PMF and 1/2 PMF were then routed through the reservoir and dam.

5.3 SPILLWAY CAPACITY

The spillway capacity at the minimum top of dam is 19,761 c.f.s. There is no auxiliary or emergency spillway.

5.4 RESERVOIR CAPACITY

The storage capacity of Glenham Dam at normal pool is 25 acre-feet. The storage capacity of the reservoir at the minimum top of dam is 43 acre-feet. Therefore, the flood control storage of the reservoir between the spillway crest and the top of the dam is 18 acre-feet. This volume represents a total runoff of 0.002 inches from the drainage area.

5.5 FLOOD OF RECORD

The maximum flow at the USGS gage 1300 feet downstream was 19,737 c.f.s. during Agnes in 1972; this should have just come to the top of the dam. The person contacted at the dam had only been associated with the dam for a short time and had no knowledge of the depth of flow over the spillway during this flood event.

5.6 OVERTOPPING POTENTIAL

The maximum capacity of the spillway is 19,761 c.f.s. at the minimum top of dam. The peak outflows of the PMF and 1/2 PMF are 60,570 c.f.s. and 30,287 c.f.s., respectively. Therefore, the spillway is capable of passing 33 percent of the PMF before overtopping would occur.

5.7 RESERVOIR EMPTYING POTENTIAL

The reservoir can be drawn down by means of a 4.5-foot diameter brick conduit at the toe of the dam. Neglecting inflow, the reservoir can be drawn down from normal pool in approximately one hour. This is equivalent to an approximate drawdown rate of 25 feet per hour, based on the hydraulic height measured from normal pool divided by the time to dewater the reservoir.

5.8 EVALUATION

Glenham Dam is an "intermediate" size - "high" hazard dam requiring the spillway to pass a flood in the range of PMF. The PMF and 1/2 PMF were routed through the watershed and dam. It was determined that the spillway is capable of passing 33 percent of the PMF before overtopping the dam. Structural stability analysis based on available information, indicate that factors of safety against overturning are less than desirable. When the dam is subjected to severe loading conditions such as a 1/2 PMF or PMF event, the factors of safety fall below the stable levels. The spillway is, therefore, judged to be "seriously inadequate."

Conclusions pertain to present conditions and the effect of future development on the hydrology has not been considered.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations - No signs of instability were noted during the field inspection. Problems observed which could affect the stability of the structure include:
1. Numerous seeps through the brickwork of the dam.
 2. Several locations where the mortar has disintegrated and washed out from the brickwork.
 3. Severe degradation of the concrete surfaces of the dam.
 4. Several places where the concrete facing has fallen off of the dam exposing the brickwork.

As a result of the visual inspection of these items, it is recommended that an in-depth study of the seepage and its effect on the brickwork and stability of the dam be performed. This in-depth study should result in the implementation of appropriate remedial measures.

- b. Design and Construction Data - No design information regarding the stability of the structure was available.
- c. Operating Records - No operating records were available for review.
- d. Post Construction Changes - The structure was raised 7 feet in 1914. At that time, a cutoff; discharge basin; and other dam improvements were performed. Newspaper articles attached in Appendix G are the only available information source concerning these improvements.

6.2 STABILITY ANALYSIS

The results of any previous stability analyses were unavailable for reference during this evaluation. A section at the overflow was selected for analysis because it appeared to represent the most critical section. The cases analyzed and respective results are as follows:

<u>Case</u>	<u>Description of Loading Conditions</u>
1	Normal operating conditions with reservoir level at the spillway crest, full uplift, and tailwater corresponding to the tailwater sill elevation 128.1 ft. M.S.L.
2	Same as Case 1 with the addition of ice loading of 5000 pounds per lineal foot.
3	Reservoir level during the 1/2 PMF, full uplift, tailwater elevation of 142.0 ft. M.S.L.
4	Reservoir level during the PMF, full uplift, tailwater elevation of 147.2 ft. M.S.L.

<u>Case</u>	<u>Factor of Safety</u>		<u>Location of Resultant from Toe (ft.)</u>
	<u>Overturning</u>	<u>Sliding</u>	
1	1.45	4.78	18.00
2	1.37	4.21	15.78
3	0.91	2.58	-13.22
4	0.84	2.34	-38.25

Notes: Location of middle 1/3 is 40 to 20 feet from the downstream toe.

A negative (-) above indicates that the location of the resultant is downstream from the toe.

A value of 2 ksf was used as a conservative approximation of the shear strength of weathered rock.

In all cases, the factors of safety against overturning are generally low, and the locations of the resultants fall outside of the middle 1/3. Therefore, the dam is considered unsafe against overturning. The factor of safety against sliding was less than the recommended value of 3 for Cases 3 and 4. However, the structure has withstood normal loading conditions in the past without apparent damage, and the analyses may not indicate the true field conditions or proper loading conditions. Since overturning or sliding would result in a probable loss of life downstream of the dam, a detailed stability analysis of the dam should be performed by a qualified engineering firm within three months of owner notification.

6.3 SEISMIC STABILITY

Glenham Dam is located in Seismic Zone 1 which presents no hazard from earthquakes according to the Recommended Guidelines for Safety Inspection of Dams by the Department of the Army, Office of the Chief of Engineers. This determination is contingent on the requirements that static stability conditions are satisfactory, and conventional safety margins exist. As reported in Paragraph 6.2, the dam has low factors of safety against overturning and sliding. If the requested additional analysis does not indicate conventional safety margins against overturning and sliding, additional analysis of the effects of earthquakes on the structural stability must be performed.

SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

- a. Safety - Examination of available documents and visual inspections of Glenham Dam did not reveal any conditions which constitute an immediate hazard to human life or property.

Using the Corps of Engineers' screening criteria for review of spillway adequacy, it has been determined that the dam would be overtopped for all storms exceeding approximately 33 percent of the PMF. The overtopping of the dam could result in dam failure, increasing the hazard to loss of life downstream. Therefore, the spillway is adjudged as "seriously inadequate," and the dam is assessed as "unsafe, non-emergency."

The stability analyses of the dam performed for this investigation indicate that the factors of safety against overturning and sliding may be inadequate. In addition, an in-depth study of the seepage and affect of the seepage on the brickwork of the dam must be performed.

- b. Adequacy of Information - All evaluations and assessments in this report were based on field observations, conversations with the owner's representative, available engineering data, and office analyses. The information collected is considered adequate for a Phase I Inspection.
- c. Need for Additional Investigation - Detailed hydrologic and hydraulic investigations of the structure are considered necessary to more accurately determine the overtopping potential of the dam and to determine mitigating measures in response to the spillway inadequacy. A detailed stability analysis of the dam is considered necessary to determine actual stability conditions. An in-depth study of the seepage and effect on the brickwork must be performed.
- d. Urgency - The detailed hydrologic and hydraulic investigations and stability analyses must be initiated within three months of owner notification. The in-depth study of the seepage and effect on the brickwork must also be initiated within three months. Within one year, remedial measures resulting from these investigations must be initiated,

6

with their completion during the following year. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Around-the-clock surveillance must also be provided during these periods. The problem areas listed in Section 7.2 must be corrected within one year of notification.

7.2 RECOMMENDED MEASURES

The regular inspections and maintenance procedures presently being conducted appear to be inadequate. A thorough checklist should be compiled by the owner's representative and completed during each inspection. Maintenance items should be completed annually. Monitoring of the reservoir level should be expanded to include reservoir levels above normal pool.

Monitor the seeps in the dam at regular intervals and during periods of high reservoir levels for turbidity and increase in flow.

The following remedial measures must be completed within one year:

1. Point the joints between bricks on the right spillway training wall.
2. Repair the deteriorated concrete on the downstream side of the right wall of the dam.
3. Replace the concrete facing around the 4.5-foot diameter outlet conduit.
4. Repair the outlet pipe valve.
5. Repair the spalled and deteriorated concrete surface on the crest on the right side of the dam.
6. Repair all spalled areas on the concrete surfaces of the dam.
7. Remove all vegetation from the dam.

APPENDIX A
PHOTOGRAPHS

CONTENTS

- Photo 1 - View Looking Upstream at Right Half of Spillway
- Photo 2 - View Looking Upstream at Left Half of Spillway.
Note that Bedrock Forms Left Training Wall for
Spillway
- Photo 3 - Upstream View of Water Intake Structure
- Photo 4 - Upstream View of Outlet Gate Stem and Valve
- Photo 5 - View Across Crest of Spillway From Left Abutment
- Photo 6 - View of Downstream Headwall of Outlet and Discharge
Channel from Plant
- Photo 7 - Close-up View of Downstream Outlet Headwall
- Photo 8 - View Looking Upstream Inside Outlet Tunnel
- Photo 9 - View of Right Downstream Face of Dam. Notch Out
of Photo Center is the Location of Water Intake
Structure. This Photo is the First of a Series
of Photos Taken to Show the Right Downstream Face
of the Dam. The Photos Proceed from Upstream
to Downstream.
- Photo 10 - View of Right Downstream Face of Dam
- Photo 11 - View of Right Downstream Face of Dam. Note
Location of Red Bucket in Photo
- Photo 12 - View Looking Upstream at Right Downstream Face
of Dam
- Photo 13 - View of Seepage Through Dam (see Photo 11 for
Location of Red Bucket)
- Photo 14 - View of Old Weir Box for Measurement of Seepage
Through Dam (Location Can Be Seen on Photo 10
Where the Left Side Mirror of Vehicle is Located)

Note: Photographs were taken on 8 March 1981.

GLENHAM DAM

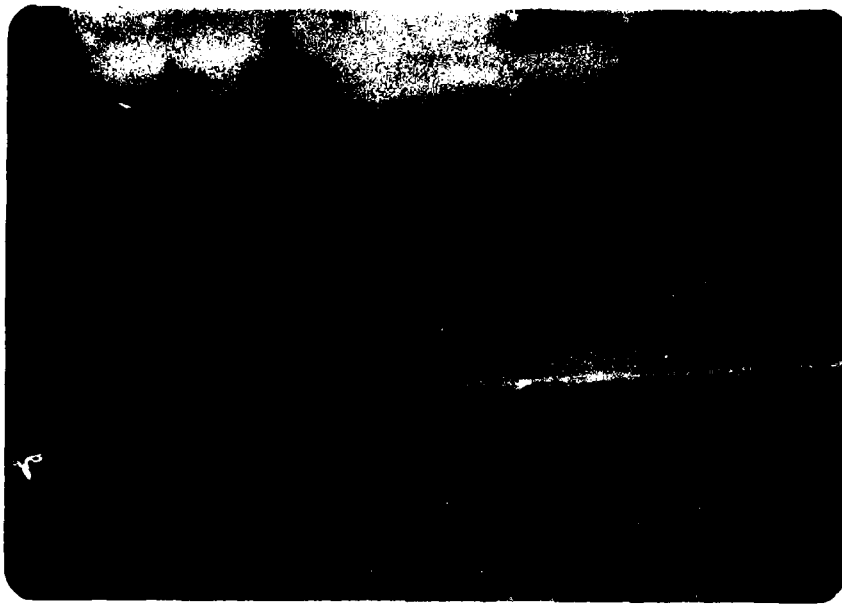


Photo 1. View Looking Upstream at Right Half of Spillway
8 March 1981



Photo 2. View Looking Upstream at Left Half of Spillway
8 March 1981

GLENHAM DAM

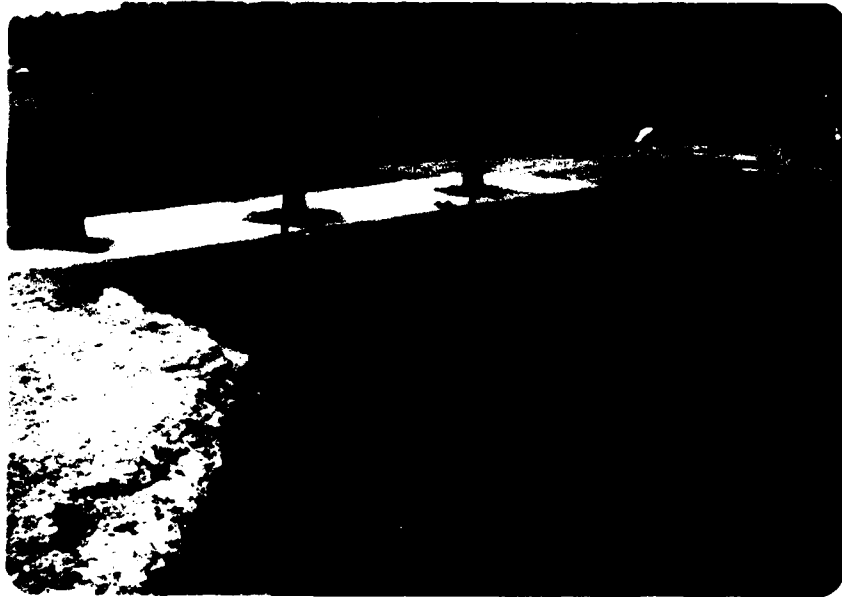


Photo 3. Upstream View of Water Intake Structure
8 March 1981



Photo 4. Upstream View of Outlet Gate Stem and Valve
8 March 1981

GLENHAM DAM



Photo 5. View Across Crest of Spillway From Left Abutment
8 March 1981



Photo 6. View of Downstream Headwall of Outlet and
Discharge Channel From Plant
8 March 1981

GLENHAM DAM



Photo 7. Close-Up View of Downstream Outlet Headwall
8 March 1981



Photo 8. View Looking Upstream Inside Outlet Tunnel
8 March 1981

GLENHAM DAM



Photo 9. View of Right Downstream Face of Dam
8 March 1981



Photo 10. View of Right Downstream Face of Dam
8 March 1981

GLENHAM DAM



Photo 11. View of Right Downstream Face of Dam
8 March 1981



Photo 12. View Looking Upstream at Right Downstream Face of Dam
8 March 1981

GLENHAM DAM



Photo 13. View of Seepage Through Dam
(See Photo 11 for Location of Red Bucket)
8 March 1981



Photo 14. View of Old Weir Box for Measurement of Seepage Through Dam
(Location Can Be Seen on Photo 10 Where the Left Side
Mirror of Vehicle is Located)
8 March 1981

APPENDIX B
VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam Glenham Dam
Fed. I.D. # NY 00072 DEC Dam No. 212C-553
River Basin Lower Hudson
Location: Town Beacon County Dutchess
Stream Name Fishkill Creek
Tributary of Hudson River
Latitude (N) 41° 30.8' Longitude (W) 73° 56.7'
Type of Dam Masonry gravity dam
Hazard Category High
Date(s) of Inspection 8 March 1981
Weather Conditions Cloudy, 38° F.
Reservoir Level at Time of Inspection 180.0 ft.

b. Inspection Personnel James G. Ulinski, Anthony P. Klimek and Steve Lockington

c. Persons Contacted (Including Address & Phone No.) (914) 831-1300
Rino Furlani - Chief of Maintenance
Beacon Textile Printers, Ltd.
Mill and Front Street
Beacon, NY 12508

d. History:

Date Constructed 1875 Date(s) Reconstructed 1911-1915
Designer Original unknown
Constructed By Original unknown
Owner Original unknown

Designer (1911-1915): Fred D. Rhodes and Edward N. Friedman
Architects: Freedman, Robertson and Keeler
Constructed By: Murphy Brothers of New York City
Owner: Glenham Embroidery Company

2) Embankment - Not Applicable

a. Characteristics

- (1) Embankment Material _____

- (2) Cutoff Type _____

- (3) Impervious Core _____

- (4) Internal Drainage System _____

- (5) Miscellaneous _____

b. Crest

- (1) Vertical Alignment _____

- (2) Horizontal Alignment _____

- (3) Surface Cracks _____

- (4) Miscellaneous _____

c. Upstream Slope

- (1) Slope (Estimate) (V:H) _____

- (2) Undesirable Growth or Debris, Animal Burrows _____

(3) Sloughing, Subsidence, or Depressions _____

(4) Slope Protection _____

(5) Surface Cracks or Movement at Toe _____

d. Downstream Slope

(1) Slope (Estimate - V:H) _____

(2) Undesirable Growth or Debris, Animal Burrows _____

(3) Sloughing, Subsidence or Depressions _____

(4) Surface Cracks or Movement at Toe _____

(5) Seepage _____

(6) External Drainage System (Ditches, Trenches, Blanket) _____

(7) Condition Around Outlet Structure _____

(8) Seepage Beyond Toe _____

e. Abutments - Embankment Contact _____

(1) Erosion at Contact _____

(2) Seepage Along Contact _____

3) Drainage System

a. Description of System None observed

b. Condition of System Not applicable

c. Discharge from Drainage System Not applicable

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) None

5) Reservoir

- a. Slopes The slopes immediately adjacent to the reservoir are steep rock outcroppings.
- b. Sedimentation Sedimentation was not directly observed, however, it is not reported to be a significant problem.
- c. Unusual Conditions Which Affect Dam None observed.

6) Area Downstream of Dam

- a. Downstream Hazard (No. of Homes, Highways, etc.) A factory, Beacon Textile Printers, Ltd., is located about 100 feet downstream of the dam. Loss of life in this factory is likely if the dam were to fail.
- b. Seepage, Unusual Growth Clear water was flowing out of the rock on the left abutment at about 5 to 10 gpm (gallons per minute) about 30 ft. below the spillway.
- c. Evidence of Movement Beyond Toe of Dam None observed.
- d. Condition of Downstream Channel The downstream channel is bound by a steep rock face on the left side and a cutstone vertical river wall, about 7 ft. high, on the right side.

7) Spillway(s) (Including Discharge Conveyance Channel)

- a. General The spillway consists of a rounded concrete ogee-shaped weir 140 ft. wide (measured perpendicular to the flow) and has a rounded crest approximately 6 ft. wide. The upstream face of the spillway is vertical for about 10 ft. below the crest, then slopes to the bottom of the reservoir at about a 1H:1V slope. The downstream face of the spillway has a slope of about 1H:1V across its entire width. The spillway is bound by the 11-ft. high vertical concrete face of the dam on the right side and two nearly vertical rock outcroppings on the left side. The right side of the downstream spillway face is bound by a stone and brick wall.
- b. Condition of Service Spillway There was a foot of water going over the crest of the spillway at the time of inspection, making observation difficult. There were no major cracks observed in the spillway, and it appeared to be in fair condition. The concrete on the right training wall was badly spalled, and mortar was missing from some of the joints in the stone on the right training wall.
- c. Condition of Auxiliary Spillway None
- d. Condition of Discharge Conveyance Channel The spillway discharges into a stilling basin 65 ft. long and 140 ft. wide. This basin is bound by a vertical rock outcropping on the left side and a 2-ft. wide concrete wall on the right side. The basin discharges into the natural river by dropping over a 3-ft. high by 1-ft. wide rounded, concrete end sill extending across the downstream end of the stream basin.

8) Reservoir Drain/Outlet

Type: Pipe _____ Conduit X Other _____

Material: Concrete _____ Metal _____ Other Bricklined

Size: 4.5 ft. dia. Length 84 ft. (estimated from plans)

Invert Elevations: Entrance 129.7 (estimated) Exit 128.7

Physical Condition (Describe): Unobservable X

Material: Bricklined conduit

Joints: Unobservable Alignment According to the plans, there are two 45° bends in the pipe

Structural Integrity: Unobservable

Hydraulic Capability: No problems observed.

Means of Control: Gate _____ Valve X Uncontrolled _____

Operation: Operable _____ Inoperable _____ Other X

Present Condition (Describe): Water was flowing through the conduit at the time of inspection. According to the chief of maintenance, the valve can be opened, but it cannot be entirely closed; therefore, water always flows through the conduit.

9) Structural

- a. Concrete Surfaces Nearly every concrete surface on the dam was badly spalled and deteriorated. In some places, the concrete had eroded as much as 6 in. There were some small trees, grass and vines growing on some of the surfaces. The concrete around the valve controls was in good shape and without signs of spalling. In some places, the eroded concrete exposed a brick wall about 8 in. behind the concrete surface.
- b. Structural Cracking None observed
- c. Movement - Horizontal & Vertical Alignment (Settlement) None observed
- d. Junctions with Abutments or Embankments The right side of the dam joins the right abutment at a rock outcropping. There were no problems observed at this junction. The left side of the spillway joins the left abutment at a vertical rock face. The left junction was under water and could not

be observed at the time of inspection. No information was available about possible keying into the abutments.

- e. Drains - Foundation, Joint, Face None observed.
- f. Water Passages, Conduits, Sluices There are four valves that control the water flow through the dam. One valve controls the 5-foot diameter outlet pipe for the dam; this valve was partially opened at the time of inspection. The three other valves are located beside one another and control the flow through pipes that go into Beacon Textile Printers, Ltd. One valve was completely opened and supplying water to the factory at the time of inspection. According to the Chief of Maintenance, with the exception of the valve that controls the outlet and cannot be completely closed, the valves are in working condition and are operated every three or four months.
- g. Seepage or Leakage There were six separate seeps observed near the dam base. They were all flowing clear with no signs of turbidity and varied between 0.5 and 10 gpm in estimated rate of flow.
- h. Joints - Construction, etc. In places, the spalled concrete has revealed the brick wall, and water is seeping through the joints of the brick where the mortar has been washed out. There is grass growing in the joints between the stone facing. There appears to be no problem in the joints between badly spalled concrete and the good concrete located around the valves.
- i. Foundation According to design plans, the dam is built on a surface of rock and hard pan.
- j. Abutments No problems observed.
- k. Control Gates None

1. Approach & Outlet Channels There is no approach or outlet channel for the spillway.
 - m. Energy Dissipators (Plunge Pool, etc.) The spillway discharges into a stilling basin extending across the spillway width (140 ft.) and is 65 ft. long. This basin is bound by a vertical rock outcropping on the left side and a 2-foot wide concrete wall on the right side. The basin discharges into the natural river by flowing over a 3-foot high by 1-foot wide end sill extending across the basin width.
 - n. Intake Structures The inlets were under water and unobservable at the time of inspection. However, iron grating, utilized as a trash rack, was observed over the inlet areas to the three valves controlling the water flow to the factory.
 - o. Stability No signs of instability were noted during the visual inspection.
 - p. Miscellaneous The right side of the dam is perpendicular to the spillway crest. The dam is "L"-shaped.
- 10) Appurtenant Structures (Power House, Lock, Gatehouse, Other)
- a. Description and Condition None
- _____
- _____
- _____
- _____
- _____

APPENDIX C
HYDROLOGIC/HYDRAULIC DATA AND COMPUTATIONS

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject GLENHAM DAM S.O. No. _____

APPENDIX C - HYDROLOGIC AND Sheet No. _____ of _____

HYDRAULIC CALCULATIONS Drawing No. _____

Computed by _____ Checked by _____ Date _____

<u>SUBJECT</u>	<u>PAGE</u>
CHECK LIST FOR DAMS	1
TOP OF DAM PROFILE	5
TYPICAL CROSS SECTIONS	6
SPILLWAY PROFILE	7
SPILLWAY RATING	8
OUTLET PIPE RATING	9
OUTLET PIPE RATING SUMMARY	12
PMF DISCHARGE	13
SPILLWAY CAPACITY ANALYSIS	14
HEC-1 DB COMPUTER ANALYSIS	15

CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

AREA-CAPACITY DATA:

	<u>Elevation (ft.)</u>	<u>Surface Area (acres)</u>	<u>Storage Capacity (acre-ft.)</u>
1) Top of Dam	<u>169.6</u>	<u>1.90</u>	<u>43</u>
2) Design High Water (Max. Design Pool)	<u>-----</u>	<u>----</u>	<u>--</u>
3) Auxiliary Spillway Crest	<u>-----</u>	<u>----</u>	<u>--</u>
4) Pool Level with Flashboards	<u>-----</u>	<u>----</u>	<u>--</u>
5) Service Spillway Crest	<u>159.0</u>	<u>1.45</u>	<u>25</u>

DISCHARGES

	<u>Volume (cfs)</u>
1) Average Daily	<u>279</u>
2) Spillway @ Maximum High Water - Top of Dam -	<u>19,761</u>
3) Spillway @ Design High Water	<u>---</u>
4) Spillway @ Auxiliary Spillway Crest Elevation	<u>---</u>
5) Low Level Outlet	<u>406</u>
6) Total (of all facilities) @ Maximum High Water	<u>20,167</u>
7) Maximum Known Flood	<u>Unknown</u>
8) At Time of Inspection	<u>450</u>

CREST:

ELEVATION: 169.6 ft.

Type: Concrete

Width: 8.5 ft. to 24 ft. Length: 312 ft.

Spillover

Location Near left abutment

SPILLWAY:

SERVICE

AUXILIARY

159.00 Ft.

Elevation None

Type

6.5 ft.

Width

Type of Control

X

Uncontrolled

Controlled:

Type

(Flashboards; gate)

Number

Size/Length

Invert Material

Anticipated Length
of Operating Service

Chute Length

10 ft.

Height Between Spillway Crest
& Approach Channel Invert
(Weir Flow)

HYDROMETEROLOGICAL GAGES:

Type: None

Location: _____

Records: _____

Date: _____

Max. Reading: _____

FLOOD WATER CONTROL SYSTEM:

Warning System: None

Method of Controlled Releases (mechanisms):

Three valves on the crest control water to the adjacent factory, and one
valve controls the 4.5 ft. diameter conduit that outlets at the toe of the
dam.

DRAINAGE AREA: 188.57 sq. mi.

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: Mostly rural

Terrain - Relief: Gently sloping

Surface - Soil: Well drained

Runoff Potential (existing or planned extensive alterations to existing surface or subsurface conditions)

No known plans for altering the existing runoff patterns.

Potential Sedimentation problem areas (natural or man-made; present or future)

None observed

Potential Backwater problem areas for levels at maximum storage capacity including surcharge storage:

None observed

Dikes - Floodwalls (overflow & non-overflow) - Low reaches along the Reservoir perimeter:

Location: None

Elevation: _____

Reservoir:

Length @ Maximum Pool 1100 ft.

Length of Shoreline (@ Spillway Crest) 2300 ft.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject GLENHAM DAM
TOP-OF-DAM PROFILE

S.O. No. _____

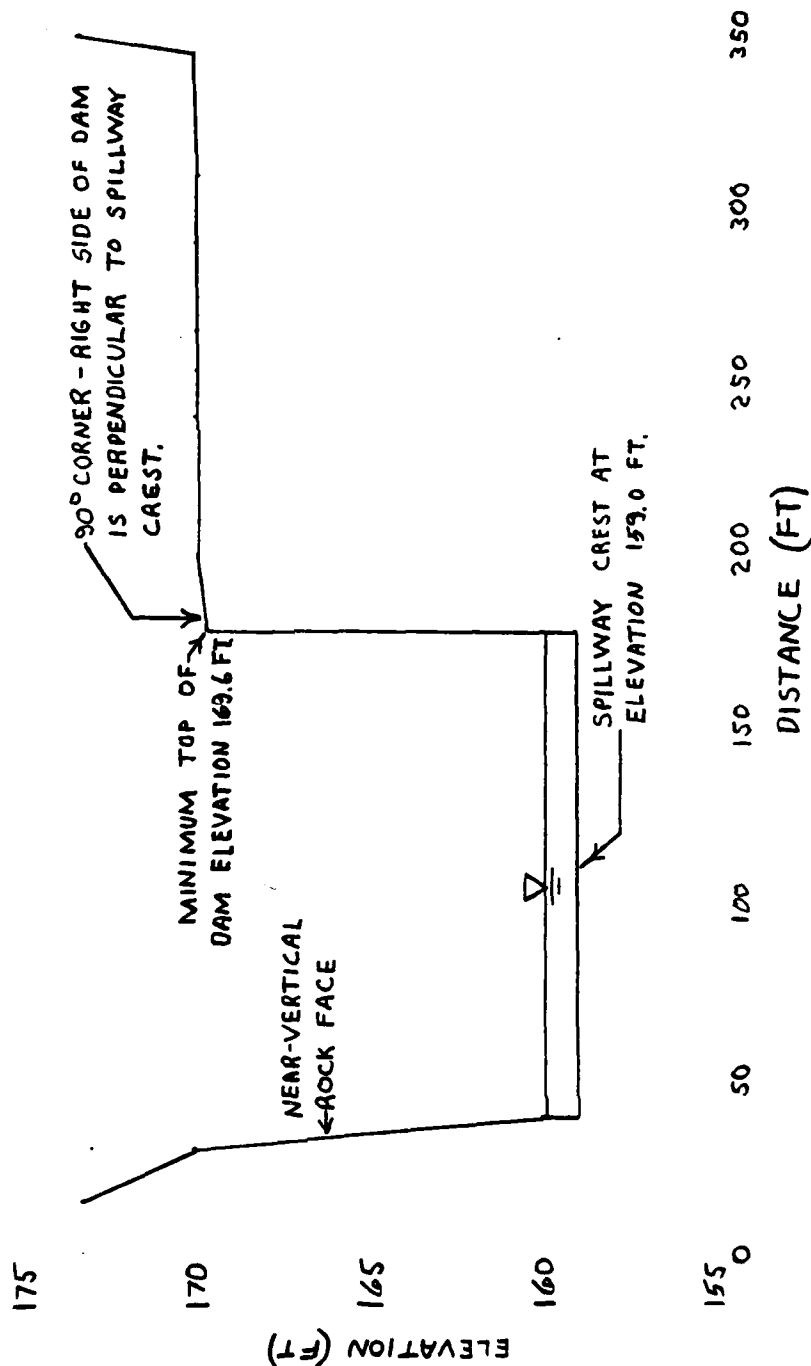
Sheet No. 5 of 24

Drawing No. _____

Computed by APK Checked by SE

Date 3-12-61

TOP OF DAM PROFILE (LOOKING DOWNSTREAM)



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Subject GLENHAM DAM

CROSS SECTIONS OF DAM

S.O. No. _____

Sheet No. 6 of 24

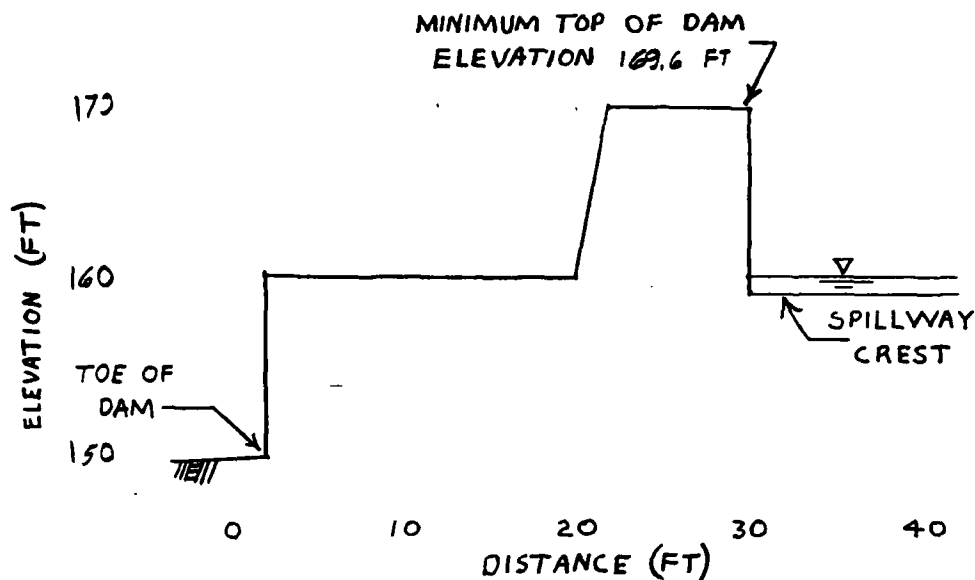
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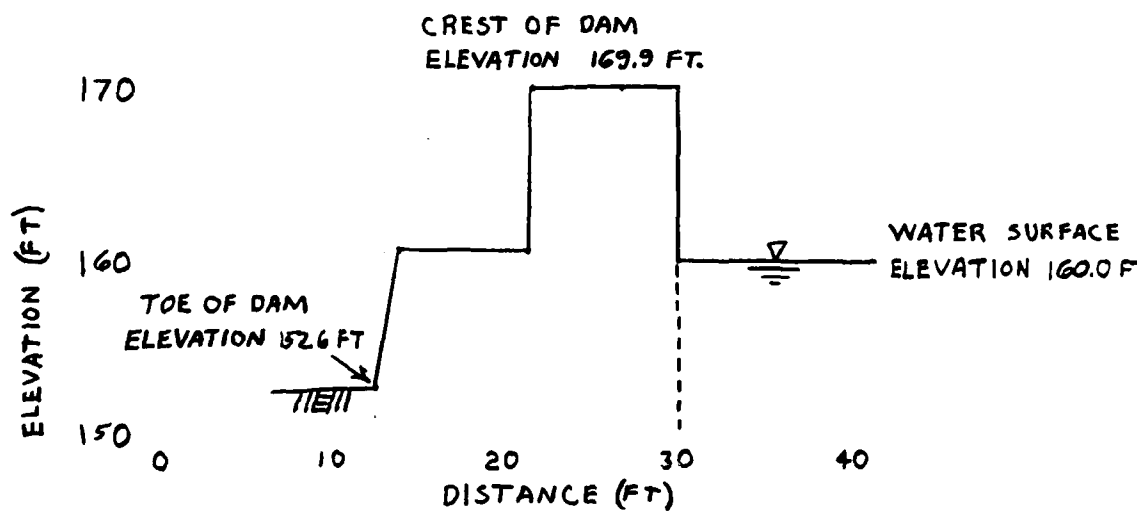
Checked by JE

Date 3-12-81

CROSS-SECTION AT STATION 1+82



CROSS SECTION AT STATION 2+57



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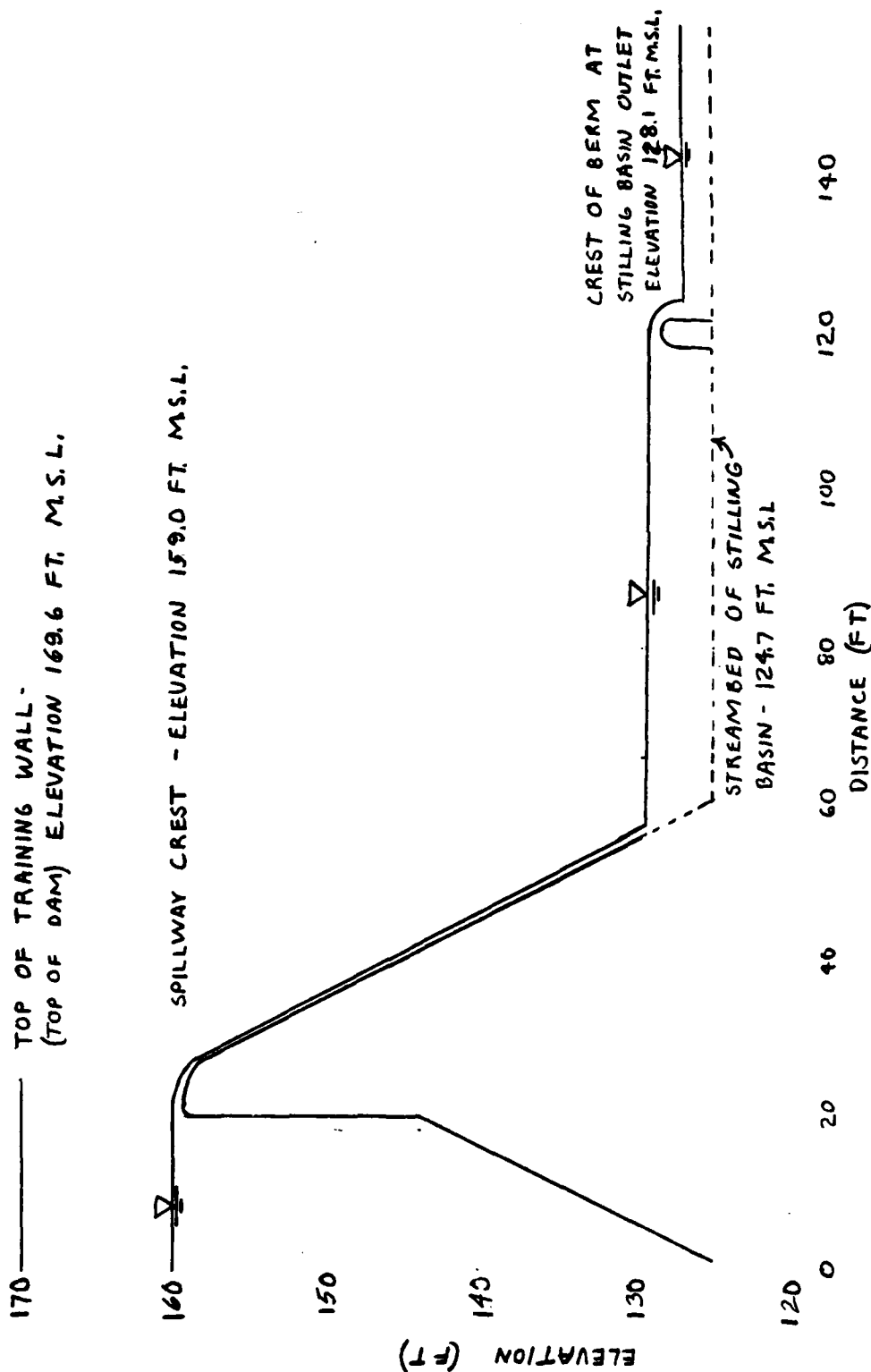
Subject GLENHAM DAM
SPILLWAY PROFILE

S.O. No. _____

Sheet No. 7 of 24

Drawing No. _____

Computed by APK Checked by JS Date 3-20-61



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject GLENHAN DAM S.O. No. _____
SPILLWAY RATING Sheet No. 8 of 24
Drawing No. _____
Computed by GWT Checked by WDL Date 5/27/81

SPILLWAY PROFILE

SPILLWAY IS CONCRETE, ROUNDED WEIR WITH
VERTICAL UPSTREAM FACE.

THE GENERALIZED DESIGN CURVES FOR SHAPING OGEE-WEIRS
IN DESIGN OF SMALL DAMS, U.S. DEPT. OF THE INTERIOR,
BUREAU OF RECLAMATION, WERE USED TO DETERMINE
THAT THE DESIGN HEAD FOR THIS WEIR IS
APPROXIMATELY 5.0 FEET.

$$(H_0 = 5.0 \text{ Ft})$$

$$\frac{\text{APPROACH DEPTH}}{H_0} = \frac{10.0}{5.0} = 2.0$$

USING FIG. 2A9 IN DESIGN OF SMALL DAMS:

FOR $\frac{L}{H_0} = 2.0$, C_0 FOR A VERTICAL-FACED WEIR IS 3.94

WEIR FLOW

$$Q = CLH^{3/2}$$

ELEVATION (FT)	C	H	Q (CFS)
159.0	3.1	0	0
160.0	3.34	1	467.6
161.0	3.55	2	1405.7
162.0	3.70	3	2691.6
163.0	3.82	4	4278.4
165.0	4.01	6	8250.9
167.0	4.04	8	12,798.1
169.0	4.08	10	18,062.9
169.6	4.09	10.6	19,761.1
171.0	4.12	12	23,977.1
175.0	4.19	16	37,542.4
179.0	4.25	20	53,218.4
183.0	4.33	24	71,274.3

L = 140 FT.
H VARIES FROM
0 TO 24 FEET
C VARIES WITH
H, FROM FIG. 250
IN "DESIGN OF
SMALL DAMS"

MICHAEL BAKER, JR., INC.
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Box 280
Beaver, Pa. 15009

Subject GLENHAM DAM

OUTLET PIPE RATING

S.O. No. _____

Sheet No. 9 of 24

Drawing No. _____

Computed by GWT

Checked by LAD

Date 5/11/81

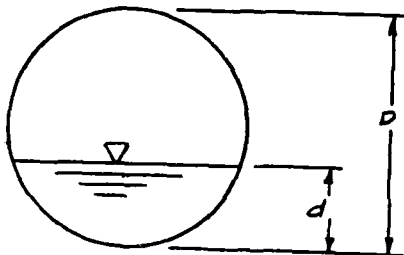
INLET ELEV. - 129.7 FT. (ASSUMED) /

OUTLET ELEV. - 128.7 FT. /

LENGTH - 84 FEET /

4.5 FOOT BRICK LINED CONDUIT I. D. /
 $n = 0.017$

"DESIGN OF SMALL DAMS" PAGES 558 AND 559



D = DIA. PIPE

d = DEPTH OF WATER

S = PIPE SLOPE

$$= \frac{129.7 - 128.7}{84} = .0119 /$$

ELEVATION 132.0 FT.

$$\frac{d}{D} = \frac{2.25}{4.5} = .5 \text{ TABLE B-2 } 1.3955 = \frac{Q_0}{D^{5/2}} = \frac{Q}{4.5^{5/2}} \quad Q = 59.9 \text{ CFS. /}$$

$$\frac{d}{D} = \frac{2.25}{4.5} = .5 \text{ TABLE B-3 } .232 = \frac{Qn}{D^{5/2}} = \frac{Q(0.017)}{4.5^{5/2}(.0119)^{1/2}} \quad Q = 82.2 \text{ CFS. /}$$

ELEVATION 133.0

$$\frac{d}{D} = \frac{3.4}{4.5} = .75 \text{ TABLE D-2 } 3.0607 = \frac{Q_0}{D^{5/2}} = \frac{Q}{(4.5)^{5/2}} \quad Q = 131.5 \text{ CFS. /}$$

$$\frac{d}{D} = \frac{3.4}{4.5} = .75 \text{ TABLE B-3 } .422 = \frac{Qn}{D^{5/2}} = \frac{Q(0.017)}{(4.5)^{5/2}(.0119)^{1/2}} \quad Q = 149.5 \text{ CFS. /}$$

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Box 280
Beaver, Pa. 15009

Subject GLENHARD DAM

OUTLET PIPE RATING

S.O. No. _____

Sheet No. 10 of 21

Drawing No. _____

Computed by GWT

Checked by LAD

Date 5/1/01

ORIFICE FLOW

$$Q = CA (2gH)^{.5}$$
$$Q = 77.83 H^{.5} /$$

$$A = \pi R^2 = \pi \left(\frac{4.5}{2}\right)^2 = 15.90 \text{ SQ. FT.} /$$
$$g = 32.2 \text{ FT/SEC}^2 \quad -$$
$$H \text{ VARIES} \quad -$$
$$C = .61 \text{ FROM TABLE 4-5 \& 4-6}$$
$$\text{BRATER \& KING} \quad -$$
$$d = 4.5 \text{ FT.} \quad -$$

HEAD MEASURED TO CENTER OF PIPE

ELEVATION (FT)	H (FT) ✓	Q (CFS) ✓
135.5	3.5	146
136.0	4.0	156
137.0	5.0	174
138.0	6.0	191
140.0	8.0	220
142.0	10.0	246
144.0	12.0	270
146.0	14.0	291
148.0	16.0	311
150.0	18.0	330
152.0	20.0	348
154.0	22.0	365
156.0	24.0	381
158.0	26.0	397
159.0	27.0	404

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Box 280
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Subject GLENNHART DAM
OUTLET PIPE RATING

S.O. No. _____

Sheet No. 11 of 24

Drawing No. _____

Computed by GWT Checked by LAD Date 5/1/81

PIPE FLOW

$$Q = \frac{A (2gH)^{1/2}}{[1 + K_e + K_b + K_c (L)]^{1/2}}$$

$$= \frac{15.90 (64.4 H)^{1/2}}{[1 + .70 + 1.2 + (.0072)(84)]^{1/2}}$$

$$Q = 67.39 H^{1/2}$$

ELEVATION (FT)	H (FT) /	Q (CFS)
136.0	2.8	113.
137.0	3.8	131.
138.0	4.8	148.
140.0	6.8	176.
142.0	8.8	200.
144.0	10.8	221.
146.0	12.8	241.
148.0	14.8	259.
150.0	16.8	276.
152.0	18.8	292.
154.0	20.8	307.
156.0	22.8	322.
158.0	24.8	336.
159.0	25.8	342.

$$A = \pi R^2 = \left(\frac{4.5}{2}\right)^2 \pi = 15.90 \text{ SQ. FT.}$$

$$g = 32.2 \text{ FT/SEC}^2$$

H VARIES AND IS MEASURED
FROM THE TOP OF PIPE
ELEV. AT THE OUTLET

$$L = 84 \text{ FT.}$$

$$K_e (K_b) = 0.70 \text{ PG. 5.5-6}$$

SCS NEH-5

$$K_b (K_s) = .80 \text{ PG. 5.5-10 (2 Bands)}$$

SCS NEH-5

$$K_c (K_p) = .0072 \text{ PG. 5.5-4}$$

SCS NEH-5

$$n = .017$$

TOP OF PIPE AT OUTLET
ELEV. - 137.2 FT.

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Box 280
Beaver, Pa. 15009

Subject GLENHART DAM S.O. No. _____
OUTLET PIPE RATING SUMMARY Sheet No. 12 of 24
Drawing No. _____
Computed by GWT Checked by LAD Date 5/1/81

OUTLET PIPE RATING SUMMARY

ELEVATION (FT)	Q. (CFS)
129.7	0
132.0	60
133.0	131
137.0	131
138.0	148
140.0	176
142.0	200
144.0	221
146.0	241
148.0	259
150.0	276
152.0	292
154.0	307
156.0	322
158.0	336
159.0	342

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Subject GLENHART DAM

PIF DISCHARGE

S.O. No. _____

Sheet No. 13 of 24

Drawing No. _____

Computed by GWT Checked by WDL

Date 4/28/81

WEIGHTED C_p VALUE FOR DRAINAGE AREA
WEIGHTED RAINFALL VALUE FOR SPS
FISHKILL CREEK

SUBAREA	AREA	C_p	T_p	RAINFALL
1	76.4	.42	13.50	12.31
2	7.95	.35	6.20	13.69
3	58.5	.48	15.44	12.00
4	15.6	.43	6.44	12.20
5	31.5	.44	8.00	11.61

$$\frac{83.63}{189.95} = 0.44 \quad C_p \text{ WEIGHTED}$$

$$\frac{2,207.35}{189.95} = 12.15 \quad \text{RAINFALL WEIGHTED}$$

SPS Q AT NODE 103 IS 26,207 CFS
(FROM "LOWER HUDSON RIVER BASIN HYDROLOGIC FLOOD
ROUTING MODEL" PAGES 79-88)

HYDROGRAPH DEVELOPED AT NODE 103 USING $t_p = 10.0$ HR.
AND $C_p = 0.44$ WITH A RAINFALL OF 12.15 INCHES
PRODUCED A FLOW OF 28,535 CFS. THE PMP RAINFALL
AMOUNT WAS THEN SUBSTITUTED TO GET THE
PIF FLOWS.

RAINFALL DATA

DAM AND DRAINAGE AREA ARE IN ZONE 1

PMP (24 HR) 200 MI.² = 22.0 IN.

DRAINAGE AREA = 188.57 SQ. MI.

PMP (6 HR) - 74% PMP (24 HR) 200 SQ. MI.

PMP (12 HR) - 89% " " "

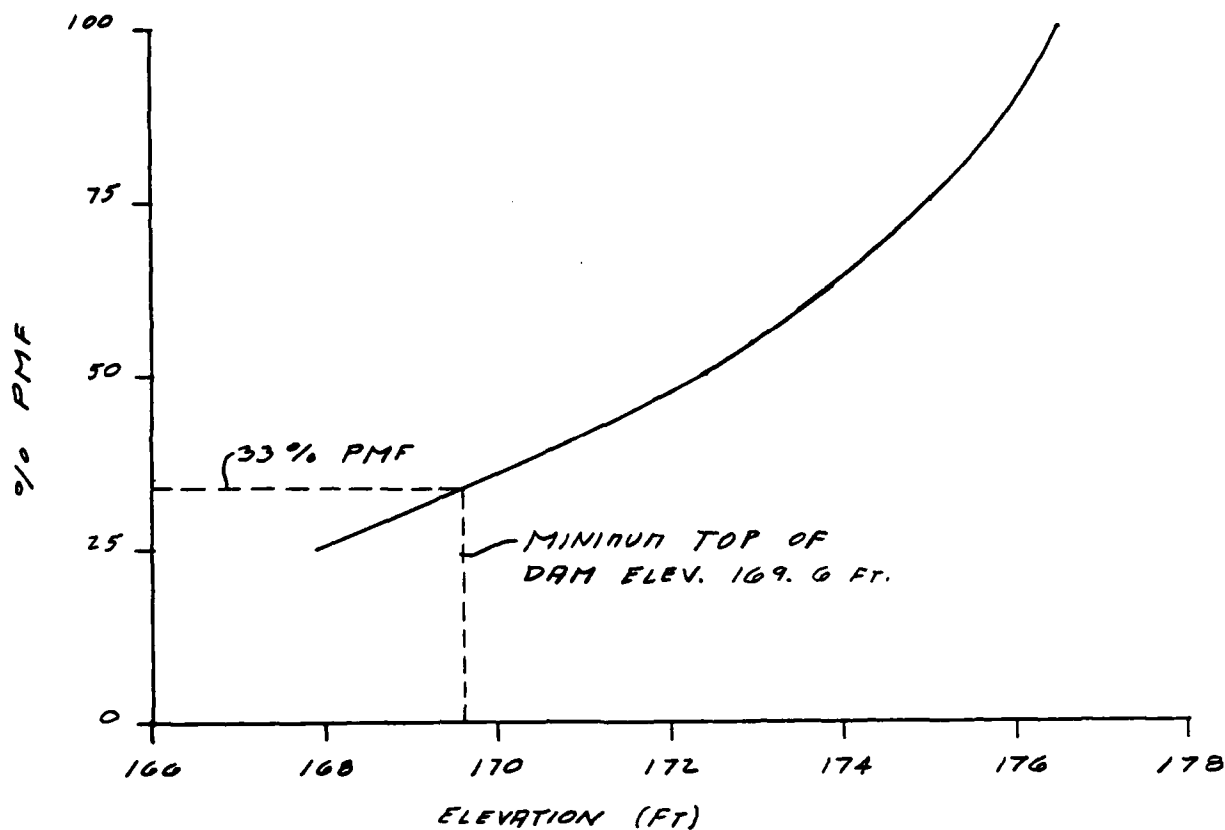
PMP (24 HR) - 100% " " "

PMP (48 HR) - 105% " " "

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Subject GLENHAM DAM S.O. No. _____
SPILLWAY CAPACITY ANALYSIS Sheet No. 14 of 24
Drawing No. _____
Computed by GWT Checked by LAD Date 5/27/81



 EQUIL HYDROGRAPH PACKAGE (HEC-1)
 C44 SAFETY VERSION JULY 1978
 LAST MODIFICATION 20 Feb 79
 MRJ UPDATE 04 JUN 79

RUN DATE 02/27/81
 TIME 14.37

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
 HYDROLOGIC AND HYDRAULIC ANALYSIS OF RESERVOIR DAM
 UNIT HYDROGRAPH BY SNYDER'S METHOD

JOB SPECIFICATION

NO	NHR	MIN	DAY	HR	MIN	SEC	IPL	1ST	ASTAN
300	2	0	0	0	0	0	0	-4	0
	JCPR	5							

MULTI-PLAN ANALYSES TO BE PERFORMED

RTIIS= 1.00 0.75 0.20 0.25 0.01
 APLAN= 1 NRTIU= 5 LRTIC= 1

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH TO DAM

STAJ	ICOMP	TECON	ITAPL	JPLI	JPKI	INATE	ISTAGE	IAUTU
1	C	C	0	0	0	-1	0	0

HYDROGRAPH DATA

IPYUJ	IUNG	IAREA	SNAP	TPSUA	IASPL	NATIU	ISAMU	ISAML	LUUAI
1	18827	0.0	18827	0.0	0.0	0.0	0	0	0

PRECIP DATA

SPFE	PM5	R6	R42	R24	R40	R72	R90
0.0	22.00	74.00	89.00	100.00	105.00	0.0	0.0

INSPC COMPUTED BY THE PROGRAM IS 0.881

LOSS DATA

LRUPT	SIKAR	CLIKR	RTICL	ERATN	STIKS	RTIKU	STIRL	CRSTL	ALSM4	KIIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	0.20	0.42	0.0	0.0

UNIT HYDROGRAPH DATA

IP= 10.00 CPSC= 0.00 RTIA= 0

RECESSION DATA

SIMU= -1.20 LRSME= -0.02 RTIUK= 2.00

UNIT HYDROGRAPH 40 EQU-CR-PERIOD UNKNOWNS, LAG= 13.00 HOURS, CP= 0.44 VLE= 1.00
 399. 148. 296. 437. 527. 525. 478. 422. 370. 325.
 251. 221. 203. 177. 150. 130. 122. 100. 95.
 14. 11. 8. 5. 3. 2. 1. 0. 0. 0.

NO.0A H4.M1 PERIOD PAIN EXCS LOSS COMP U H4.0A H4.M1 PERIOD H4.1 EXCS LOSS COMP V
 END-OF-PERIOD FLUX
 SUT 20.35 11.73 8.62 730041.
 (217.11 258.11 219.112039.55)

SHEET 17 OF 24									
ROUTING FOR GLENHAP DAM									
HYDROGRAPH ROUTING									

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO LOGARITHMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CFS) (MILLION CFS PER SECOND)
 AREA IN SQUARE FEET (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
				1.00	6.75	9.50	9.25	9.01
HYDROGRAPH AT	1	188.57 (488.39)	1	60564	53378	30222	32126	902
				(1713.25)	(1284.97)	(856.55)	(428.52)	(17.13)
ROUTED TO	2	188.57 (488.39)	1	60564	53378	30222	32126	902
				(1714.52)	(1286.14)	(857.61)	(428.77)	(17.14)

1

SHEET 19 OF 24

LINE	DESCRIPTION	DATE	BY	REVISION	REMARKS
1	ELIQU HYDROGRAPH PACKAGE (EHC-11)	JULY 1976			
2	ELIQU SAFETY VERSION	20 FEB 75			
3	LAST MODIFICATION	04 JUN 75			
4	483 UPDAIL				
5	NATURAL PROGRAM FOR INSPECTION OF NON-FLUENTIAL DAMS				
6	HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLENFAM DAM				
7	DEMATERING ANALYSIS OF GLENFAM DAM				
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					

Run DATE 05/27/11 TIME 15.44

NATIONAL PROGRAM FOR INSPECTION OF NON-FUNCTIONAL DAMS HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLENFAN DAM DETERMINING ANALYSIS OF GLENFAN DAM

NOT 1031417365 APR

NO	NAME	DATE	TIME	PLACE	REMARKS
1	JOHN	10/10/50	10:00	1000	1000
2	JOHN	10/10/50	10:00	1000	1000
3	JOHN	10/10/50	10:00	1000	1000
4	JOHN	10/10/50	10:00	1000	1000
5	JOHN	10/10/50	10:00	1000	1000
6	JOHN	10/10/50	10:00	1000	1000
7	JOHN	10/10/50	10:00	1000	1000
8	JOHN	10/10/50	10:00	1000	1000
9	JOHN	10/10/50	10:00	1000	1000
10	JOHN	10/10/50	10:00	1000	1000
11	JOHN	10/10/50	10:00	1000	1000
12	JOHN	10/10/50	10:00	1000	1000
13	JOHN	10/10/50	10:00	1000	1000
14	JOHN	10/10/50	10:00	1000	1000
15	JOHN	10/10/50	10:00	1000	1000
16	JOHN	10/10/50	10:00	1000	1000
17	JOHN	10/10/50	10:00	1000	1000
18	JOHN	10/10/50	10:00	1000	1000
19	JOHN	10/10/50	10:00	1000	1000
20	JOHN	10/10/50	10:00	1000	1000
21	JOHN	10/10/50	10:00	1000	1000
22	JOHN	10/10/50	10:00	1000	1000
23	JOHN	10/10/50	10:00	1000	1000
24	JOHN	10/10/50	10:00	1000	1000
25	JOHN	10/10/50	10:00	1000	1000
26	JOHN	10/10/50	10:00	1000	1000
27	JOHN	10/10/50	10:00	1000	1000
28	JOHN	10/10/50	10:00	1000	1000
29	JOHN	10/10/50	10:00	1000	1000
30	JOHN	10/10/50	10:00	1000	1000
31	JOHN	10/10/50	10:00	1000	1000
32	JOHN	10/10/50	10:00	1000	1000
33	JOHN	10/10/50	10:00	1000	1000
34	JOHN	10/10/50	10:00	1000	1000
35	JOHN	10/10/50	10:00	1000	1000
36	JOHN	10/10/50	10:00	1000	1000
37	JOHN	10/10/50	10:00	1000	1000
38	JOHN	10/10/50	10:00	1000	1000
39	JOHN	10/10/50	10:00	1000	1000
40	JOHN	10/10/50	10:00	1000	1000
41	JOHN	10/10/50	10:00	1000	1000
42	JOHN	10/10/50	10:00	1000	1000
43	JOHN	10/10/50	10:00	1000	1000
44	JOHN	10/10/50	10:00	1000	1000
45	JOHN	10/10/50	10:00	1000	1000
46	JOHN	10/10/50	10:00	1000	1000
47	JOHN	10/10/50	10:00	1000	1000
48	JOHN	10/10/50	10:00	1000	1000
49	JOHN	10/10/50	10:00	1000	1000
50	JOHN	10/10/50	10:00	1000	1000
51	JOHN	10/10/50	10:00	1000	1000
52	JOHN	10/10/50	10:00	1000	1000
53	JOHN	10/10/50	10:00	1000	1000
54	JOHN	10/10/50	10:00	1000	1000
55	JOHN	10/10/50	10:00	1000	1000
56	JOHN	10/10/50	10:00	1000	1000
57	JOHN	10/10/50	10:00	1000	1000
58	JOHN	10/10/50	10:00	1000	1000
59	JOHN	10/10/50	10:00	1000	1000
60	JOHN	10/10			

MULTI-PLAN ANALYSES TO BE PERFORMED
APIAN=1 NRTHU=1 LBTIG=1

ETICS = 1.00

SUR-AREA RUNOFF (CAPITAL) IN

NULL RUNOFF HYDROGRAPH IS DAM

INSTAQ	ICOMP	IECGN	IIAPE	JPLT	JPRY	INATE	JSTAGE	IAUTU
1	1	1	0	0	0	-1	0	0

HYDROGRAPH DATA

INDWG	LUNG	TAREA	SNAP	TRSCA	TRSPC	RATIO	ISNUW	ISAME	LOCAL
-1	0	189.57	C.C	186.57	0.0	0.0	0	0	0

INFLUENCE OF HYDROGRAPH

[illegible]

PEAK	6-HOUR	12-HOUR	TOTAL VOLUME
1	1.0	1.0	2.0
2	1.0	1.0	2.0
3	1.0	1.0	2.0
4	1.0	1.0	2.0
5	1.0	1.0	2.0
6	1.0	1.0	2.0
7	1.0	1.0	2.0
8	1.0	1.0	2.0
9	1.0	1.0	2.0
10	1.0	1.0	2.0
11	1.0	1.0	2.0
12	1.0	1.0	2.0
13	1.0	1.0	2.0
14	1.0	1.0	2.0
15	1.0	1.0	2.0
16	1.0	1.0	2.0
17	1.0	1.0	2.0
18	1.0	1.0	2.0
19	1.0	1.0	2.0
20	1.0	1.0	2.0
21	1.0	1.0	2.0
22	1.0	1.0	2.0
23	1.0	1.0	2.0
24	1.0	1.0	2.0
25	1.0	1.0	2.0
26	1.0	1.0	2.0
27	1.0	1.0	2.0
28	1.0	1.0	2.0
29	1.0	1.0	2.0
30	1.0	1.0	2.0
31	1.0	1.0	2.0
32	1.0	1.0	2.0
33	1.0	1.0	2.0
34	1.0	1.0	2.0
35	1.0	1.0	2.0
36	1.0	1.0	2.0
37	1.0	1.0	2.0
38	1.0	1.0	2.0
39	1.0	1.0	2.0
40	1.0	1.0	2.0
41	1.0	1.0	2.0
42	1.0	1.0	2.0
43	1.0	1.0	2.0
44	1.0	1.0	2.0
45	1.0	1.0	2.0
46	1.0	1.0	2.0
47	1.0	1.0	2.0
48	1.0	1.0	2.0
49	1.0	1.0	2.0
50	1.0	1.0	2.0
51	1.0	1.0	2.0
52	1.0	1.0	2.0
53	1.0	1.0	2.0
54	1.0	1.0	2.0
55	1.0	1.0	2.0
56	1.0	1.0	2.0
57	1.0	1.0	2.0
58	1.0	1.0	2.0
59	1.0	1.0	2.0
60	1.0	1.0	2.0
61	1.0	1.0	2.0
62	1.0	1.0	2.0
63	1.0	1.0	2.0
64	1.0	1.0	2.0
65	1.0	1.0	2.0
66	1.0	1.0	2.0
67	1.0	1.0	2.0
68	1.0	1.0	2.0
69	1.0	1.0	2.0
70	1.0	1.0	2.0
71	1.0	1.0	2.0
72	1.0	1.0	2.0
73	1.0	1.0	2.0
74	1.0	1.0	2.0
75	1.0	1.0	2.0
76	1.0	1.0	2.0
77	1.0	1.0	2.0
78	1.0	1.0	2.0
79	1.0	1.0	2.0
80	1.0	1.0	2.0
81	1.0	1.0	2.0
82	1.0	1.0	2.0
83	1.0	1.0	2.0
84	1.0	1.0	2.0
85	1.0	1.0	2.0
86	1.0	1.0	2.0
87	1.0	1.0	2.0
88	1.0	1.0	2.0
89	1.0	1.0	2.0
90	1.0	1.0	2.0
91	1.0	1.0	2.0
92	1.0	1.0	2.0
93	1.0	1.0	2.0
94	1.0	1.0	2.0
95	1.0	1.0	2.0
96	1.0	1.0	2.0
97	1		

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CHECK

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AC-FI

577

1

Abstract

1.01	0.10	2	0.17	0	3.00	0	125.7
1.01	0.15	3	0.75	0	3.00	0	125.7
1.01	0.20	4	0.33	0	3.00	0	125.7
1.01	0.25	5	0.42	0	3.00	0	125.7
1.01	0.30	6	0.70	0	3.00	0	125.7
1.01	0.35	7	0.24	0	3.00	0	125.7
1.01	0.40	8	0.67	0	3.00	0	125.7
1.01	0.45	9	0.75	0	3.00	0	125.7
1.01	0.50	10	0.83	0	3.00	0	125.7
1.01	0.55	11	0.52	0	3.00	0	125.7
1.01	0.60	12	1.00	0	3.00	0	125.7
1.01	0.65	13	1.08	0	3.00	0	125.7
1.01	0.70	14	1.17	0	3.00	0	125.7
1.01	0.75	15	1.25	0	3.00	0	125.7
1.01	0.80	16	1.33	0	3.00	0	125.7
1.01	0.85	17	1.42	0	3.00	0	125.7
1.01	0.90	18	1.50	0	3.00	0	125.7
1.01	0.95	19	1.58	0	3.00	0	125.7
1.01	1.00	20	1.67	0	3.00	0	125.7
1.01	1.05	21	1.75	0	3.00	0	125.7
1.01	1.10	22	1.83	0	3.00	0	125.7
1.01	1.15	23	1.92	0	3.00	0	125.7
1.01	1.20	24	2.00	0	3.00	0	125.7
1.01	1.25	25	2.08	0	3.00	0	125.7
1.01	1.30	26	2.17	0	3.00	0	125.7
1.01	1.35	27	2.25	0	3.00	0	125.7
1.01	1.40	28	2.33	0	3.00	0	125.7
1.01	1.45	29	2.42	0	3.00	0	125.7
1.01	1.50	30	2.50	0	3.00	0	125.7
1.01	1.55	31	2.58	0	3.00	0	125.7
1.01	1.60	32	2.67	0	3.00	0	125.7
1.01	1.65	33	2.75	0	3.00	0	125.7
1.01	1.70	34	2.83	0	3.00	0	125.7
1.01	1.75	35	2.92	0	3.00	0	125.7
1.01	1.80	36	3.00	0	3.00	0	125.7
1.01	1.85	37	3.08	0	3.00	0	125.7
1.01	1.90	38	3.17	0	3.00	0	125.7
1.01	1.95	39	3.25	0	3.00	0	125.7
1.01	2.00	40	3.33	0	3.00	0	125.7
1.01	2.05	41	3.42	0	3.00	0	125.7
1.01	2.10	42	3.50	0	3.00	0	125.7
1.01	2.15	43	3.58	0	3.00	0	125.7
1.01	2.20	44	3.67	0	3.00	0	125.7
1.01	2.25	45	3.75	0	3.00	0	125.7
1.01	2.30	46	3.83	0	3.00	0	125.7
1.01	2.35	47	3.92	0	3.00	0	125.7
1.01	2.40	48	4.00	0	3.00	0	125.7
1.01	2.45	49	4.08	0	3.00	0	125.7
1.01	2.50	50	4.17	0	3.00	0	125.7
1.01	2.55	51	4.25	0	3.00	0	125.7
1.01	2.60	52	4.33	0	3.00	0	125.7
1.01	2.65	53	4.42	0	3.00	0	125.7
1.01	2.70	54	4.50	0	3.00	0	125.7
1.01	2.75	55	4.58	0	3.00	0	125.7
1.01	2.80	56	4.67	0	3.00	0	125.7
1.01	2.85	57	4.75	0	3.00	0	125.7
1.01	2.90	58	4.83	0	3.00	0	125.7
1.01	2.95	59	4.92	0	3.00	0	125.7
1.01	3.00	60	5.00	0	3.00	0	125.7
1.01	3.05	61	5.08	0	3.00	0	125.7
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1.01	3.15	63	5.25	0	3.00	0	125.7
1.01	3.20	64	5.33	0	3.00	0	125.7
1.01	3.25	65	5.42	0	3.00	0	125.7
1.01	3.30	66	5.50	0	3.00	0	125.7
1.01	3.35	67	5.58	0	3.00	0	125.7

SHEET 23 OF 24

PEAK OUTFLOW IS 360. AT TIME 0.50 HOURS									
CFS CMS INCHES M4 AC-FT THOUS CU M	PEAK 26C. 10.	6-HOUR		24-HOUR		72-HOUR		TOTAL VOLUME	
		46.		33.		33.		1541.	
		1.		1.		1.		72.	
		0.00		0.00		0.00		0.00	
1.01 5.45	69	5.75	0.	0.	0.	0.	0.	0.	129.7
1.01 5.50	70	5.81	0.	0.	0.	0.	0.	0.	129.7
1.01 5.55	71	5.82	0.	0.	0.	0.	0.	0.	129.7
1.01 6.00	72	6.00	0.	0.	0.	0.	0.	0.	129.7
1.01 6.05	73	6.08	0.	0.	0.	0.	0.	0.	129.7
1.01 6.10	74	6.17	0.	0.	0.	0.	0.	0.	129.7
1.01 6.15	75	6.25	0.	0.	0.	0.	0.	0.	129.7
1.01 6.20	76	6.33	0.	0.	0.	0.	0.	0.	129.7
1.01 6.25	77	6.42	0.	0.	0.	0.	0.	0.	129.7
1.01 6.30	78	6.50	0.	0.	0.	0.	0.	0.	129.7
1.01 6.35	79	6.58	0.	0.	0.	0.	0.	0.	129.7
1.01 6.40	80	6.67	0.	0.	0.	0.	0.	0.	129.7
1.01 6.45	81	6.75	0.	0.	0.	0.	0.	0.	129.7
1.01 6.50	82	6.84	0.	0.	0.	0.	0.	0.	129.7
1.01 6.55	83	6.92	0.	0.	0.	0.	0.	0.	129.7
1.01 7.00	84	7.00	0.	0.	0.	0.	0.	0.	129.7
1.01 7.05	85	7.08	0.	0.	0.	0.	0.	0.	129.7
1.01 7.10	86	7.17	0.	0.	0.	0.	0.	0.	129.7
1.01 7.15	87	7.25	0.	0.	0.	0.	0.	0.	129.7
1.01 7.20	88	7.33	0.	0.	0.	0.	0.	0.	129.7
1.01 7.25	89	7.42	0.	0.	0.	0.	0.	0.	129.7
1.01 7.30	90	7.50	0.	0.	0.	0.	0.	0.	129.7
1.01 7.35	91	7.59	0.	0.	0.	0.	0.	0.	129.7
1.01 7.40	92	7.67	0.	0.	0.	0.	0.	0.	129.7
1.01 7.45	93	7.75	0.	0.	0.	0.	0.	0.	129.7
1.01 7.50	94	7.83	0.	0.	0.	0.	0.	0.	129.7
1.01 7.55	95	7.92	0.	0.	0.	0.	0.	0.	129.7
1.01 8.00	96	8.00	0.	0.	0.	0.	0.	0.	129.7
1.01 8.05	97	8.08	0.	0.	0.	0.	0.	0.	129.7
1.01 8.10	98	8.17	0.	0.	0.	0.	0.	0.	129.7
1.01 8.15	99	8.25	0.	0.	0.	0.	0.	0.	129.7
1.01 8.20	100	8.33	0.	0.	0.	0.	0.	0.	129.7

APPENDIX D

REFERENCES

REFERENCES

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6. Chow, Ven Te, Open Channel Hydraulics, McGraw - Hill Book Company, New York, First Edition, 1959.
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14. George, Thomas S. and Taylor, Robert S., Hydrologic Flood Routing Model For Lower Hudson River Basin, Water Resources Engineers, Inc., 8001 Forbes Place, Suite 312, Springfield, Virginia, January 1977.
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16. U.S. Army, Office of the Chief of Engineers, Engineering Circular EC-1110-2-188, "Engineering and Design, National Program of Inspection of Non-Federal Dams," Corps of Engineers, Washington, D.C., 30 December 1977.
17. U.S. Army, Office of the Chief of Engineers, Engineer Technical Letter No. ETL 1110-2-234, "Engineering and Design, National Program of Inspection of Non-Federal Dams, Review of Spillway Adequacy," Corps of Engineers, Washington, D.C., 10 May 1978.

APPENDIX E

DRAWINGS

CONTENTS

Location Plan

Watershed Map

Plate 1: Field Sketch

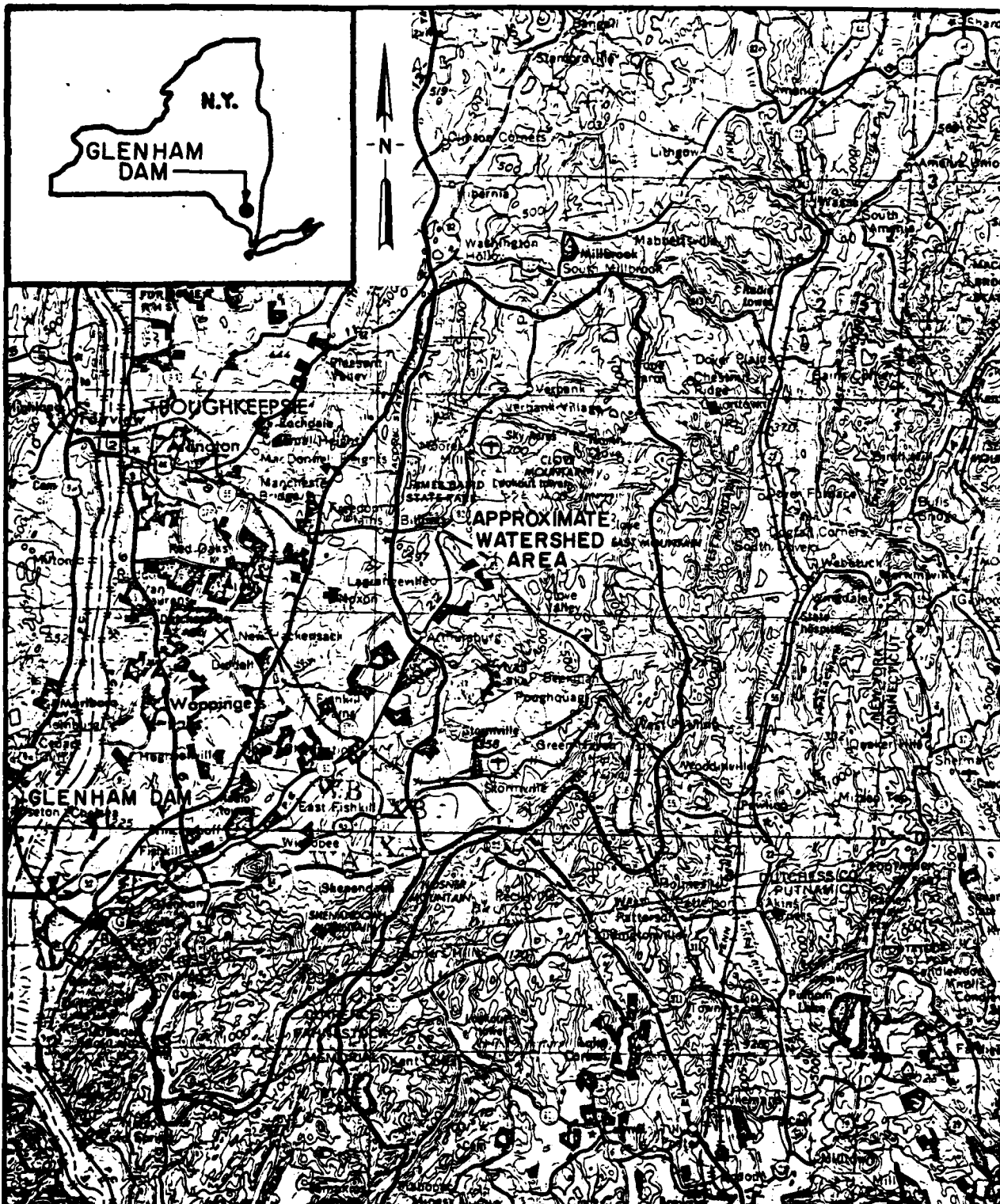
Plate 2: Plan View

Plate 3: Plan View in Sections

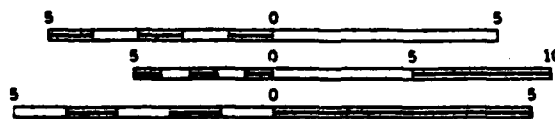
Plate 4a: Plan View in Sections

Plate 4b: Sections





Scale 1:250,000



REFERENCES:
 1. U.S.G.S. 1:250,000 HARTFORD, CONN., N.Y., N.J., MASS.
 QUADRANGLE, PHOTOREVISED 1975

WATERSHED **MAP**
GLENHAM **DAM**

FIELD SKETCH
GLENHAM DAM, N.Y.

MICHAEL BAKER JR. INC

8 MARCH 1981

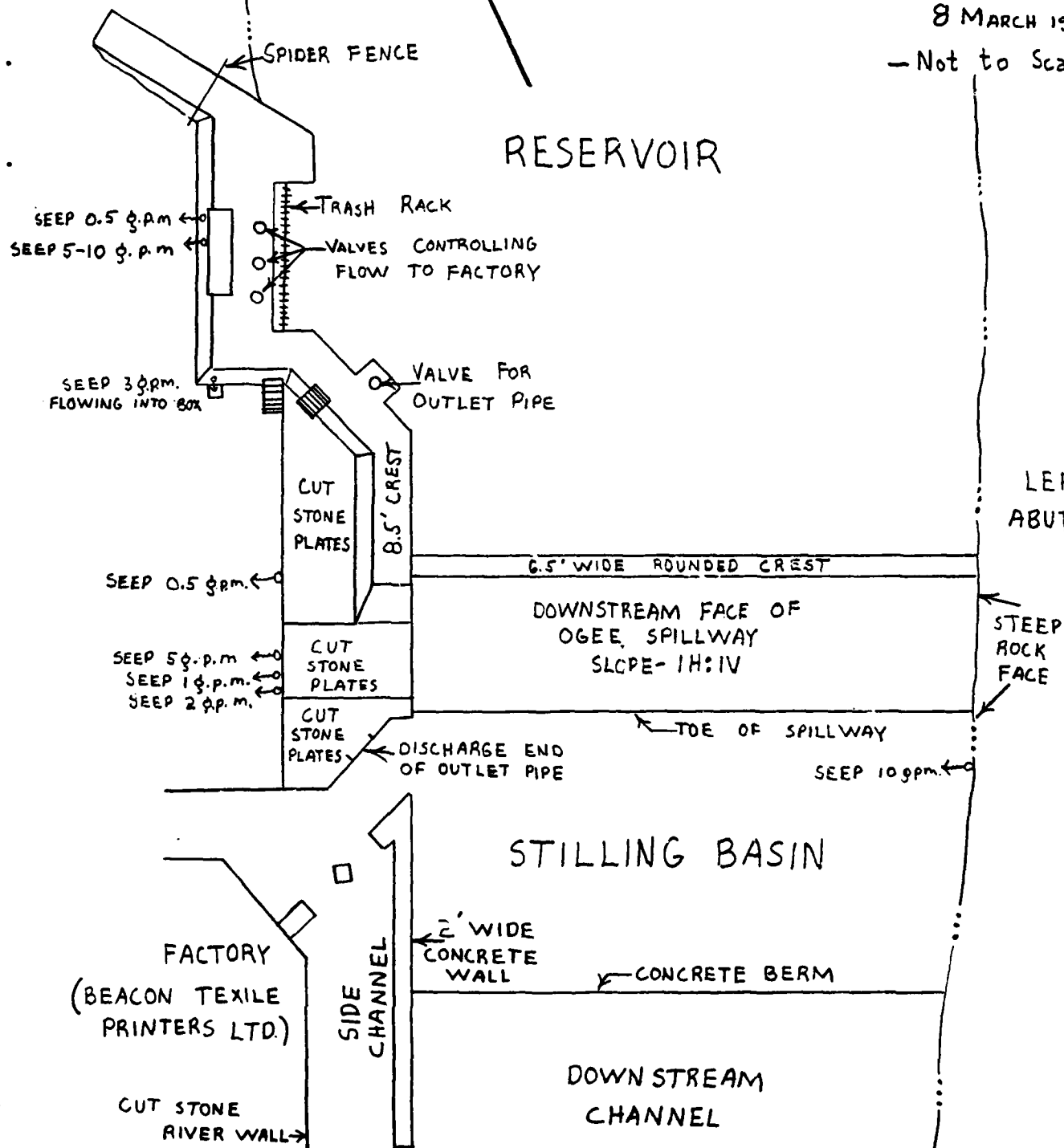
- Not to Scale -

RIGHT
ABUTMENT



RESERVOIR

LEFT
ABUTMENT

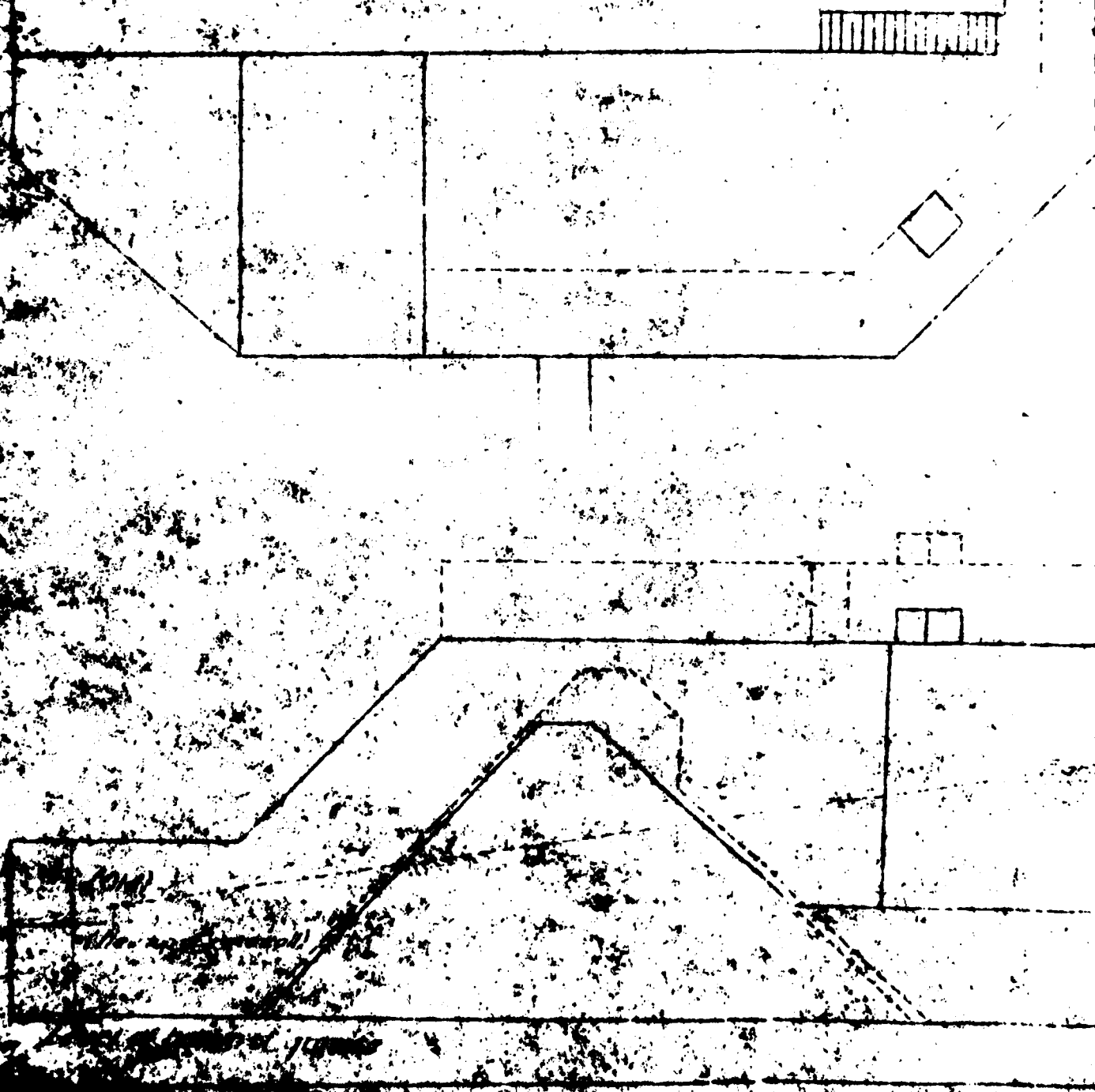


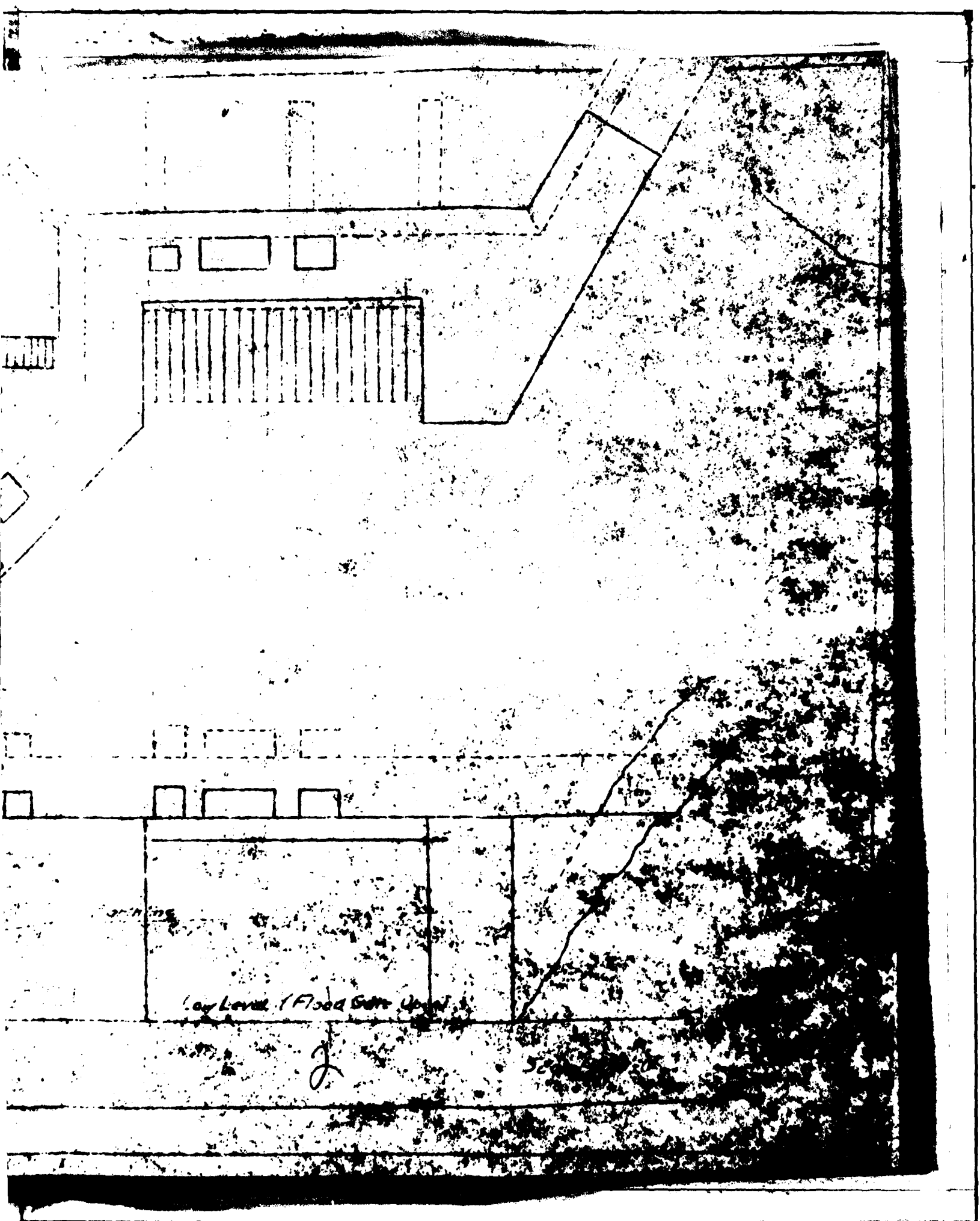
- NOTES: 1) SURFACES CAPPED WITH CUT STONE PLATES HAVE WEEDS AND BRUSH GROWING IN NEARLY EVERY JOINT.
2) VIRTUALLY EVERY CONCRETE SURFACE SHOWS SIGNS OF SPALLING

LOT AT GLENHURST, N.Y.
WITH PROPOSED ALTERATIONS

FOR

LOEB & SCHLESFELD CO.





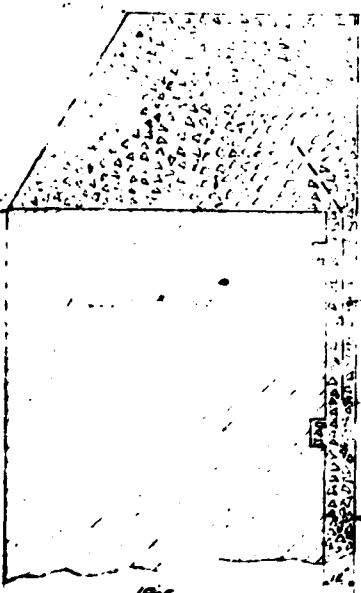
Low Level (Floor Set Up)

2

Space No.

33

Section Name
Dugout Section

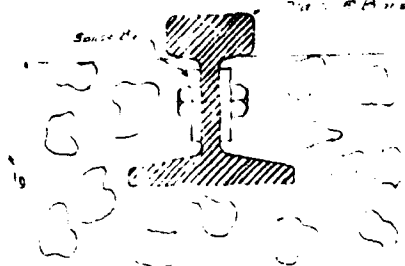


Structure in old facing 10' x 14' top
2' x 2' each way on 1" anchor. Also
7' x 8' long ground in old new project
log 8' at new lining

Bottom Headed Pipe
of 10' at

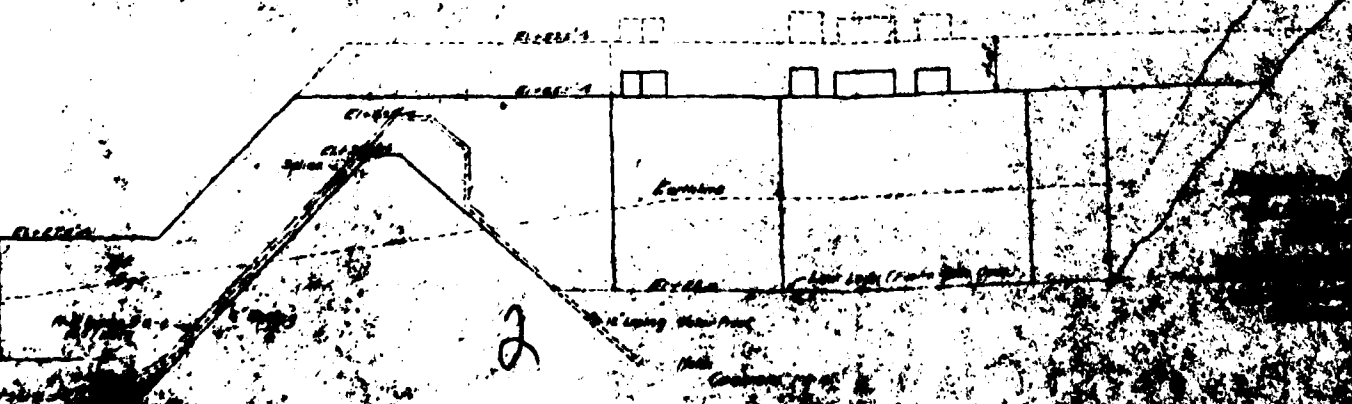
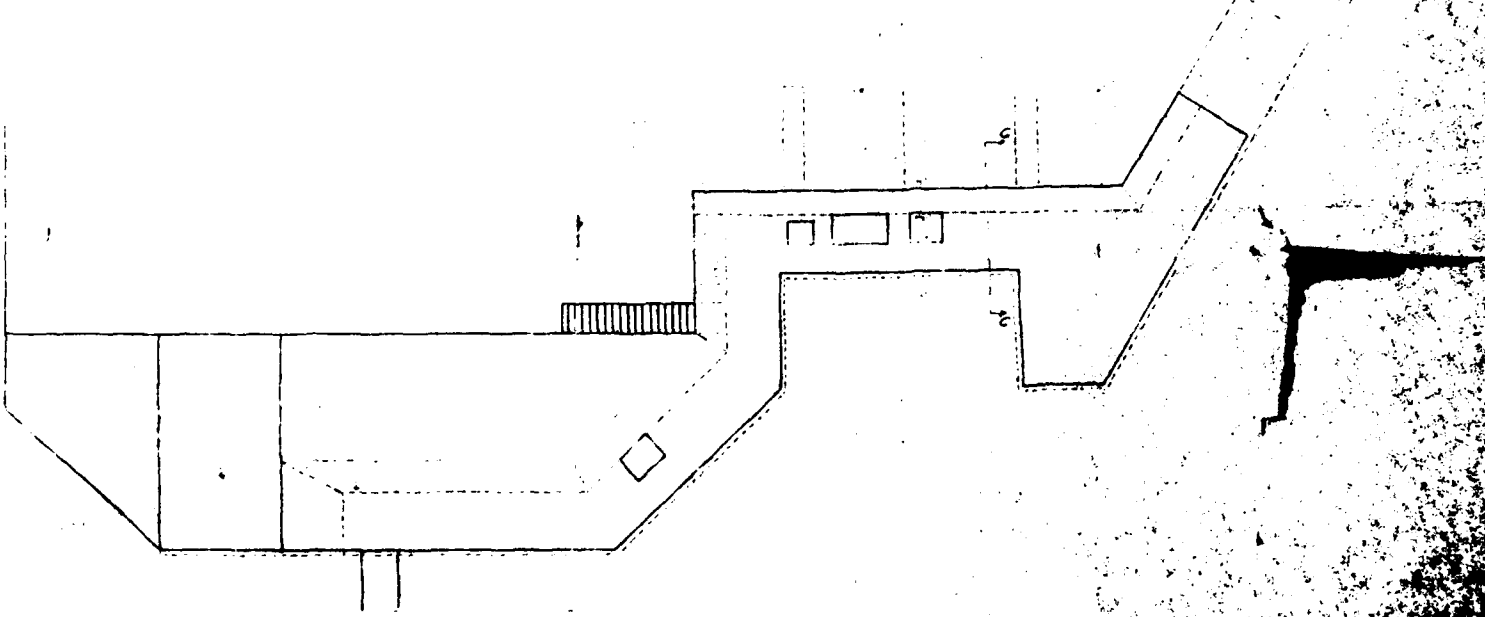
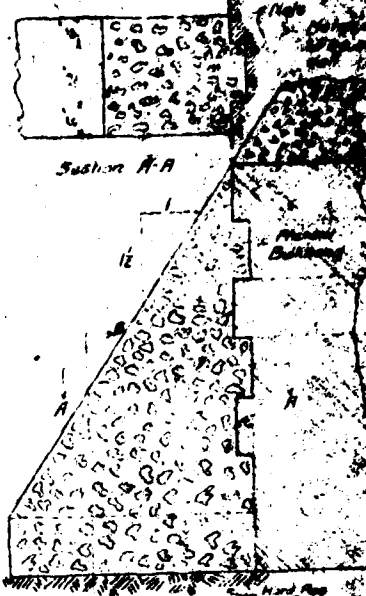
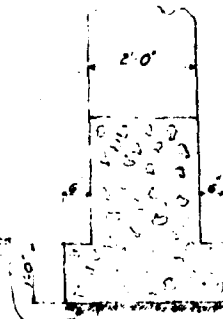
PROCEED

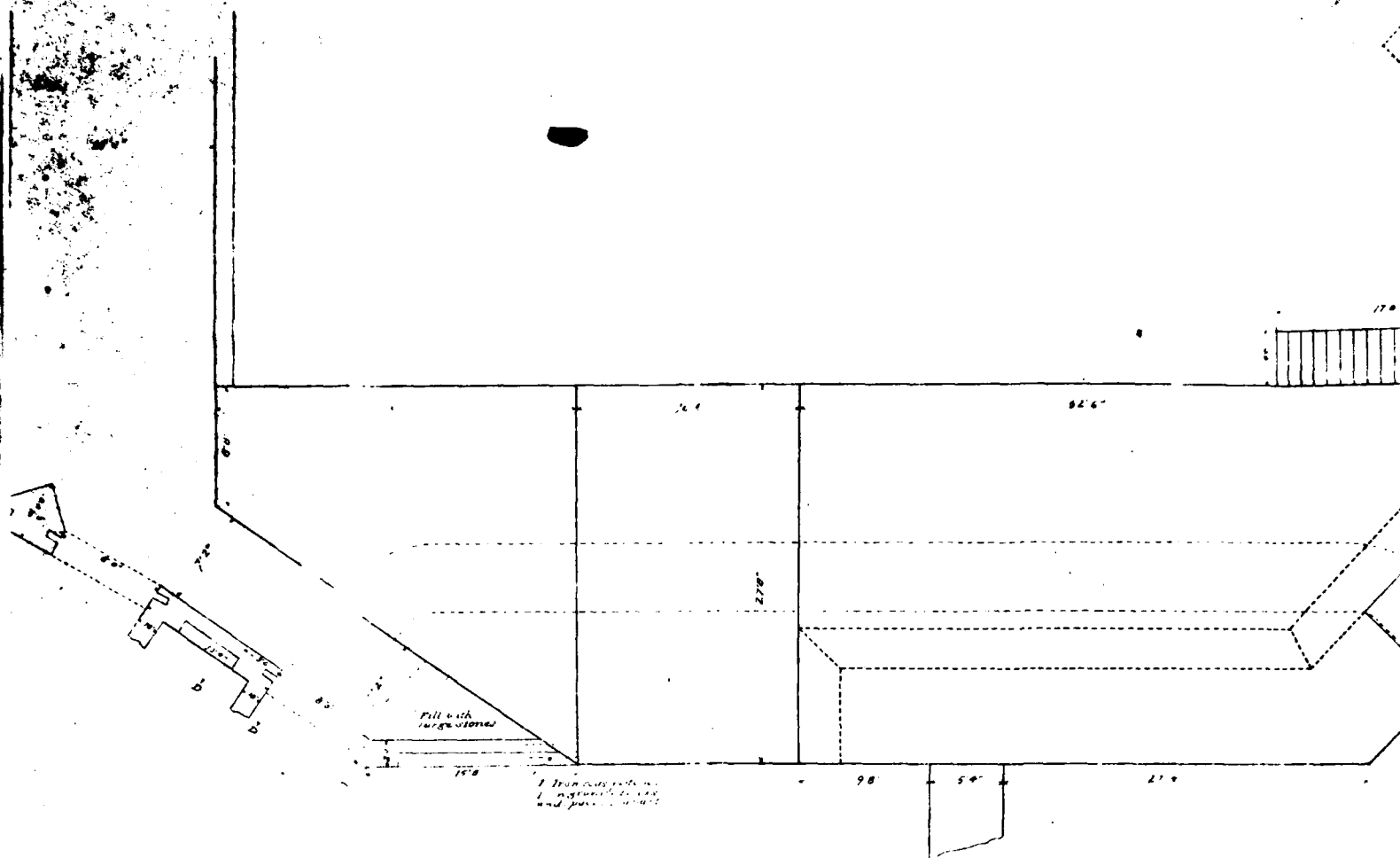
FLUORIN



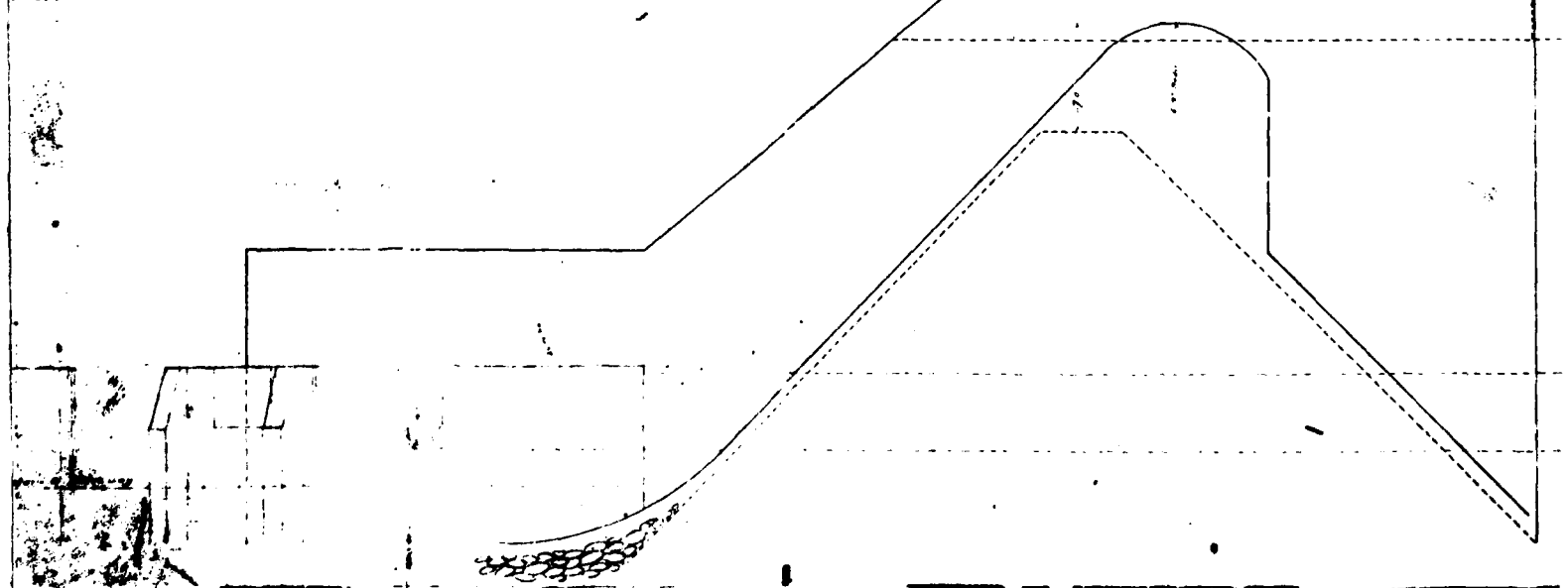
Section A-A showing Protection of
Front Slope of Face of Wing

Note: Depth Varies. Footing Courses
to be carried out to road
and - Pile





DD
and Part
by Dam
-171

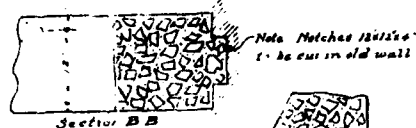


REFERS TO DAM AND BULKHEAD.
GLENHAM EMBROIDERY CO.
GLENHAM N.Y.

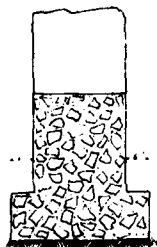
GEORGE H. FREDERICK
ENGINEERING & ARCHITECTS
30 WEST STREET
NEW YORK
N.Y.

22

2

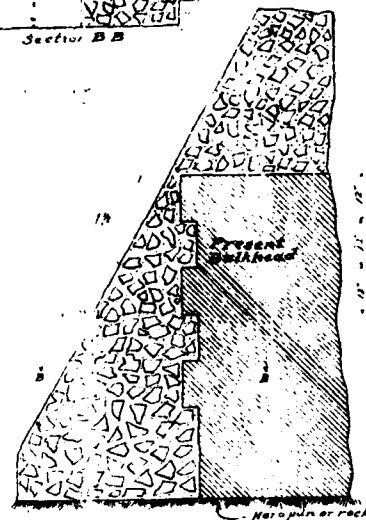


Section B B

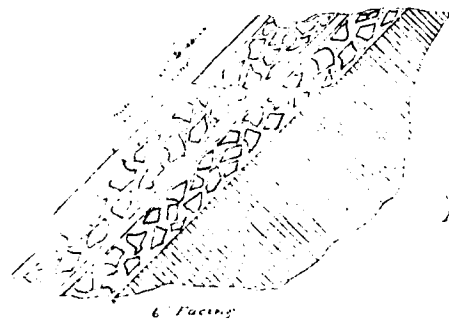


Section C C

Scale 3/4" = 1 ft.



Typical elevation of Wind Wall



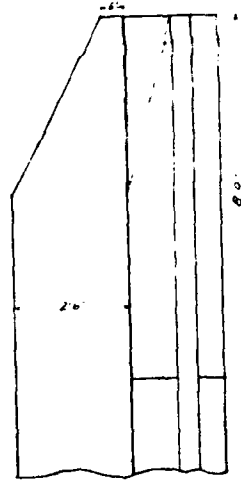
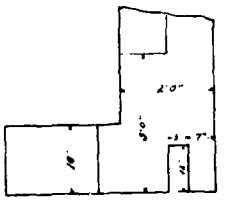
Section H H

Showing Protection of Down Stream Face of Dam

Scale 1" = 1 ft.

11 0'

1" Iron rods fastened
1 in. apart, 12 blocks
and spaced 1' apart



Section D.D.
wing walls and Piers
for Raceway Dam
Scale 3/4" = 1 ft

2

Present July 1902



APPENDIX F
BACKGROUND DOCUMENTS

DEC DAM INSPECTION REPORT

<input type="checkbox"/> 01	<input type="checkbox"/> 14	<input type="checkbox"/> 12	<input type="checkbox"/> 553	<input type="checkbox"/> 112772	<input type="checkbox"/> 004	<input checked="" type="checkbox"/> 1/
RB	CTY	YR. AP.	DAM NO.	INS. DATE	USE	TYPE

AS BUILT INSPECTION

☐ Location of Spillway and outlet

☐ Elevations

☐ Size of Spillway and outlet

☐ Geometry of Non-overflow section

Industrial Water Supply

GENERAL CONDITION OF NON-OVERFLOW SECTION

☐ Settlement

☐ Cracks

☐ Deflections

☐ Joints

☐ Surface of Concrete

☐ Leakage

☐ Undermining

☐ Settlement of Embankment

☐ Crest of Dam

☐ Downstream Slope

☐ Upstream Slope

☐ Toe of Slope

GENERAL CONDITION OF SPILLWAY AND OUTLET WORKS

☐ Auxiliary Spillway

☐ Service or Concrete Spillway

☐ Stilling Basin

☐ Joints

☐ Surface of Concrete

☐ Spillway Toe

☐ Mechanical Equipment

☐ Plunge Pool

☐ Drain

☐ Maintenance

☐ Hazard Class

☐ Evaluation

☐ Inspector

COMMENTS:

~~Texaco Research Center~~ Glenham Dam

Water now used in factory work for industrial use

553 LN

Map 212

Dam 555

L.F.

Form 1W79. 6-10-10 2000 (10-13266)

(NOTICE: After filling out one of these forms as completely as possible for each dam in your district, return it at once to the Conservation Commission, Albany.)

STATE OF NEW YORK
CONSERVATION COMMISSION
ALBANY

DAM REPORT

_____, 191____
(Date)

CONSERVATION COMMISSION,

DIVISION OF INLAND WATERS.

GENTLEMEN:

I have the honor to make the following report in relation to the structure known as the Glenham Dam.

This dam is situated upon the Fishkill Creek
(Give name of stream)
in the Town of Fishkill, Dutchess County,
about in from the Village or City of Glenham
(State distance)
The distance down stream from the dam, to the Hudson River
(Up or down) (Give name of nearest important stream or of a bridge)
is about 4 miles
(State distance)

The dam is now owned by Glenham Winery Co. / Glenham, N.Y.
(Give name of owner)
and was built in or about the year 1912, and was extensively repaired or reconstructed during the year unlabeled. 914-16.

As it now stands, the spillway portion of this dam is built of concrete
(State whether of masonry, concrete or timber)
and the other portions are built of concrete
(State whether of masonry, concrete, earth or timber with or without rock fill)

As nearly as I can learn, the character of the foundation bed under the spillway portion of the dam is see note and under the remaining portions such foundation bed is see note.

The total length of this dam is 282 feet. The spillway or waste-weir portion, is about 140 feet long, and the crest of the spillway is about 10 feet below the top of the dam.

The number, size and location of discharge pipes, waste pipes or gates which may be used for drawing off the water from behind the dam, are as follows: one 5' pipe and one 7' pipe at west end of dam

State briefly, in the space below, whether, in your judgment, this dam is in good condition, or bad condition, describing particularly any leaks or cracks which you may have observed.)

Dam is very massive and tight, in very good condition. Concrete is good.

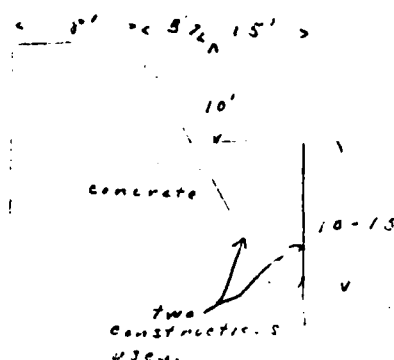
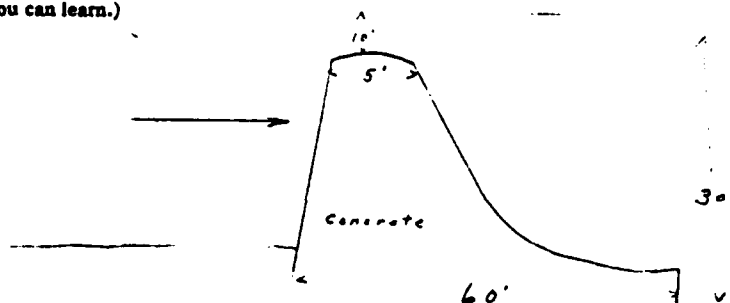
Reported by Richard L. Jeter
(Signature)

(Address—Street and number, P. O. Box or R. F. D. route)

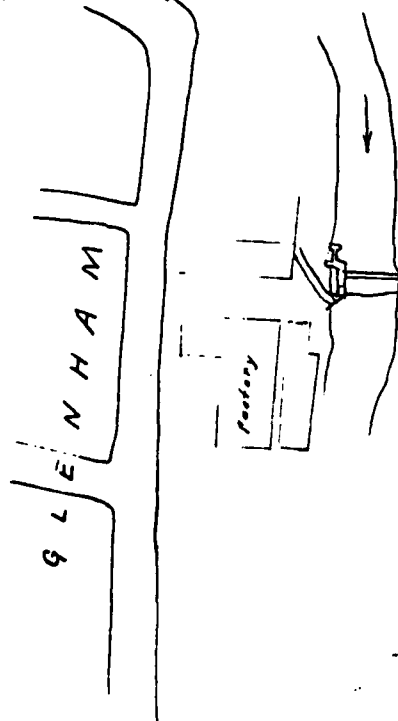
(Name of place)

(SEE OTHER SIDE)

(In the space below, make one sketch showing the form and dimensions of a cross section through the spillway or waste-weir of this dam, and a second sketch showing the same information for a cross section through the other portion of the dam. Show particularly the greatest height of the dam above the stream bed, its thickness at the top, and thickness at the bottom, as nearly as you can learn.)



(In the space below, make a third sketch showing the general plan of the dam, and its approximate position in relation to buildings or other conspicuous objects in the vicinity.)



EDWARD N. FRIEDMANN
JAMES M. ROBERTSON
FREDERICK S. KEELER

ARTHUR H. ELLIOTT
Engineer-Chemist

FRIEDMANN, ROBERTSON & KEELER
ARCHITECTS AND ENGINEERS
90 WEST STREET
NEW YORK

CABLE ADDRESS
DONACHAIDH
TELEPHONE
8576-71 RECTOR

May 17th., 1916

Alex Rice McKim Esqr

Conservation Commission,

Albany, N. Y.

My dear Mr. McKim:-

In re Dam No. 553 Lower Hudson Watershed.

Referring to our recent conversation regarding the dam at Glenham New York, owned by the Glenham Embroidery Company, I enclose two blue prints showing repairs to this dam in 1911-1912

During 1914-1915 certain repairs and alterations were made to the dam apron to prevent back scouring, and I herewith enclose photographs showing the work as it progressed.

These repairs were completed early in 1915.

Yours very truly

F. Keeler

AD-A105 821

BAKER (MICHAEL) JR INC BEAVER PA
NATIONAL DAM SAFETY PROGRAM. GLENHAM DAM (INVENTORY NUMBER N.Y.--ETC(U)
AUG 81 @ KESTER

F/G 13/13

DACHS1-81-C-0010

NL

UNCLASSIFIED

2 2

2



END
DATE
FILMED
11-4
DTIC

553

LIT

To Miss Russell
Jan. 11, '15
H.S.

Newburgh News

DEC 5 1914

Inspector McKim

NEW DAMS BUILT FOR GLENHAM CO.

Modern Structure Supplants
That of Long Ago

JOB A DIFFICULT ONE

Is One of Many Improve-
ments Made at Plant—Fac-
tory Rushed With Orders

Special to The News.

Season, Dec. 5.—For the past four months, a small army of men—masons, carpenters, engineers and laborers, have been busily engaged in repairing and constructing dams, cut-off walls, bulkheads, water sheds, etc., for the Glenham Embroidery Co. This immense piece of engineering is practically completed and today water is once more running over the big dam east of the factory.

This dam, which is 35 feet high and 142 feet long, was built in 1876, and the vast amount of water, and—in the spring of the year—ice, which rushes over it, had torn away and undermined the base, or apron to such an extent that much repairing was necessary. The work has been in charge of the Murphy Bros., builders, of 30 East 42d street, New York city. Freedman, Robertson and Keeler also of New York city were the architects. The work was chiefly for the purpose of preventing the back scour of water from undermining the big dam. The construction of a cut-off wall, located 50 feet below the dam, which extends the entire width of the creek, also dropping down to solid rock, in some places a depth of 30 feet, has been completed. A new reinforced concrete apron connecting the cut-off wall with down stream face of dam has also been built. The top of the wall extends about four feet above the apron and forms a secondary reservoir or water cushion, adding an area of 140 square feet and a depth of four feet. The object of this cushion is to take the impact of the water and ice that flows over the crest of dam. This water cushion is so constructed, it drains itself, by a system of locks.

The contractors have also been making an extension of 100 feet in length to the present raceway, with a twofold object of protecting the present sea wall from flood waters and also preventing the flood water from backing up against the water wheel and power plant.

In some places, holes 10 feet deep were dug by water in the old apron. In other places a man could crawl some 30 feet through the big openings.

A wooden flume about 8 by 8 was constructed 100 feet long to carry off water from the water wheel; also a temporary wooden cofferdam, extending the entire width of the creek at a distance of about 70 feet below the dam. This cofferdam was constructed to prevent the water from backing up and also for the safety of those employed in the work. Three pumps having a capacity of 4,000 gallons per minute were installed in pits, into which drained the water, seeping through the creek bottom. Thus a comparatively dry place for the men to work was afforded. In connection with the excavating, a trench 7 feet wide was dug to rock bottom and with heavy timber, a holdback was made from loose dirt and rock which might have interfered with the work. A cable way was installed from shore to shore for the purpose of handling machinery and such material used in this vast work. An average of 25 to 40 men a day have been employed on the contract.

The men engaged in such difficult and dangerous work were protected with such care and diligence that no accidents occurred either to men employed or the construction work itself. At times there was flowing through the temporary flume, eight feet of water, six feet deep and at a velocity of 10 feet per second. The contract is now completed and adds another to the many improvements being made since the opening of the old mill by the Embroidery Co. The concern is at present very busy with the manufacture of their lace, due to the present conditions abroad. Fred D. Rhodes was the consulting engineer in charge. Under his personal supervision, the work has given perfect satisfaction.

5-53 LN

To Miss Munnell
Sept. 29, '13
H.S.

JUL 30 1913

ENLARGE DAM AT GROVEVILLE

The Glenham Embroidery Company
Raises Structure Seven Feet to
Secure More Power

The large dam of the Glenham Embroidery Company is being heightened and widened to increase the water power of the engines of the mill. When completed the dam will be seven feet higher than the former structure and twenty feet wider. This will hold back a much larger quantity of water and greatly increase the power of the turbines. At present about 50 men are at work on the dam and have the work nearly finished.

The extension of the equipment has been in progress ever since the plant first was opened. The growth of business has necessitated the installation of additional machinery and the prospects now are that this expansion will continue.

Poughkeepsie Enterprise

JUL 31 1913

MAKE BIG DAM AT GLENHAM 7 FEET HIGHER

The large dam of the Glenham Embroidery Company is being heightened and widened to increase the water power of the engines of the mill. When completed the dam will be seven feet higher than the former structure and twenty feet wider. This will hold back a much larger quantity of water and greatly increase the power of the turbines. At present about 50 men are at work on the dam and have the work nearly finished.

The extension of the equipment has been in progress ever since the plant first was opened. The growth of business has additional machinery and the prospects now are that this expansion will continue.

*address this
to the Commission - Under*

555 Lower Hudson

FRED DANA RHODES
ASSOC. M. AM. SOC. C. E.
CONSULTING ENGINEER
FOUNDATIONS, STEEL STRUCTURES, EXPERT REPORTS
140 CEDAR STREET, NEW YORK
TELEPHONE 3084 CORTLANDT

Nov. 1, 1911.

State of New York Conservation Commission,
Alexander Rice McKim, Inspector of Docks and Dams,
Albany, N. Y.

Dear Sir:-

Please accept our thanks for yours of the 30th ultimo in relation to Fishkill Creek Dam, N.Y. The plans which we submitted are really tentative plans and some of our assumptions have been made on information from some of the men employed in the construction of the dam, together with shafts which we have sunk near the dam to determine so far as we are able the character of the soil. Two men who helped build the dam and whose names and addresses we have, informed us that the dam rested partly on rock and partly on hard-pan. The plant has been idle for some eighteen years and at the time our preliminary investigations were made we had no power with which to pump water out of the shafts which we desired to sink. We have proceeded on the theory that the dam rested partly on hard-pan and partly on rock, and it is our intention, when conditions are such that repairs can be undertaken, to construct a flume to carry off the waters from the flood gate which have thus far made it impossible to make a detailed examination. Within the past few weeks a steam plant has been put in operation, but the water has been so high that it did not seem advisable to start even the preliminary operations. We are informed that there was no core wall and that the dam was constructed entirely of broken stone and Rosendale cement. We think that the present leakage is probably due to the fact that some of the Rosendale cement is washed out. There is, however, no sign of either a crack or of slipping.

March 1912

State N. Y. Conservation Commission ----11/1/11-----#2

The order of procedure which we intend to follow is:

First--To waterproof the up-stream face of the dam without increasing its present height, and at the same time to carry off the waste water so that the toe will be entirely dry; then we should be able to know whether there is any leakage or seepage between the base of the dam and the soil or rock foundation. Second--To sink shafts at the toe of the dam in order to determine precisely the character of the soil. Third--In the event that there is no leakage and the soil is either hard-pan or rock, to increase the height of the dam, as indicated on the drawings. This particular work will be done in the following order: constructing the wing walls of the bulkhead; increasing the height of the bulkhead; surfacing and extending the down-stream face, and increasing the height of the crest.

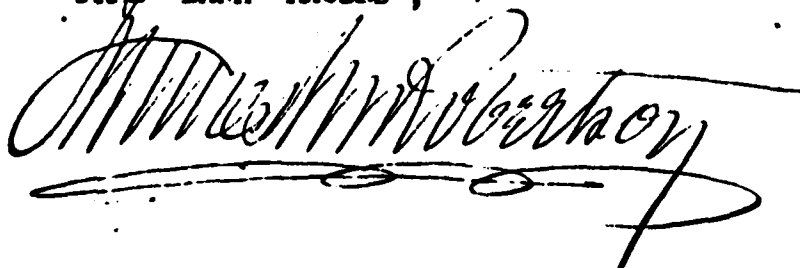
We desire to add that the dam was built about 1875.

Trusting that we may have notice of your approval of the plans executed in accordance with the provisions of this letter, we are,

Respectfully yours,

FRED DANA RHODES,

By

A large, stylized handwritten signature in dark ink, likely belonging to Fred Dana Rhodes, is written over a horizontal line.

APPENDIX G
STABILITY COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Glenham Dam
Stability Analysis
Overflow Section

Computed by JGU Checked by YDD

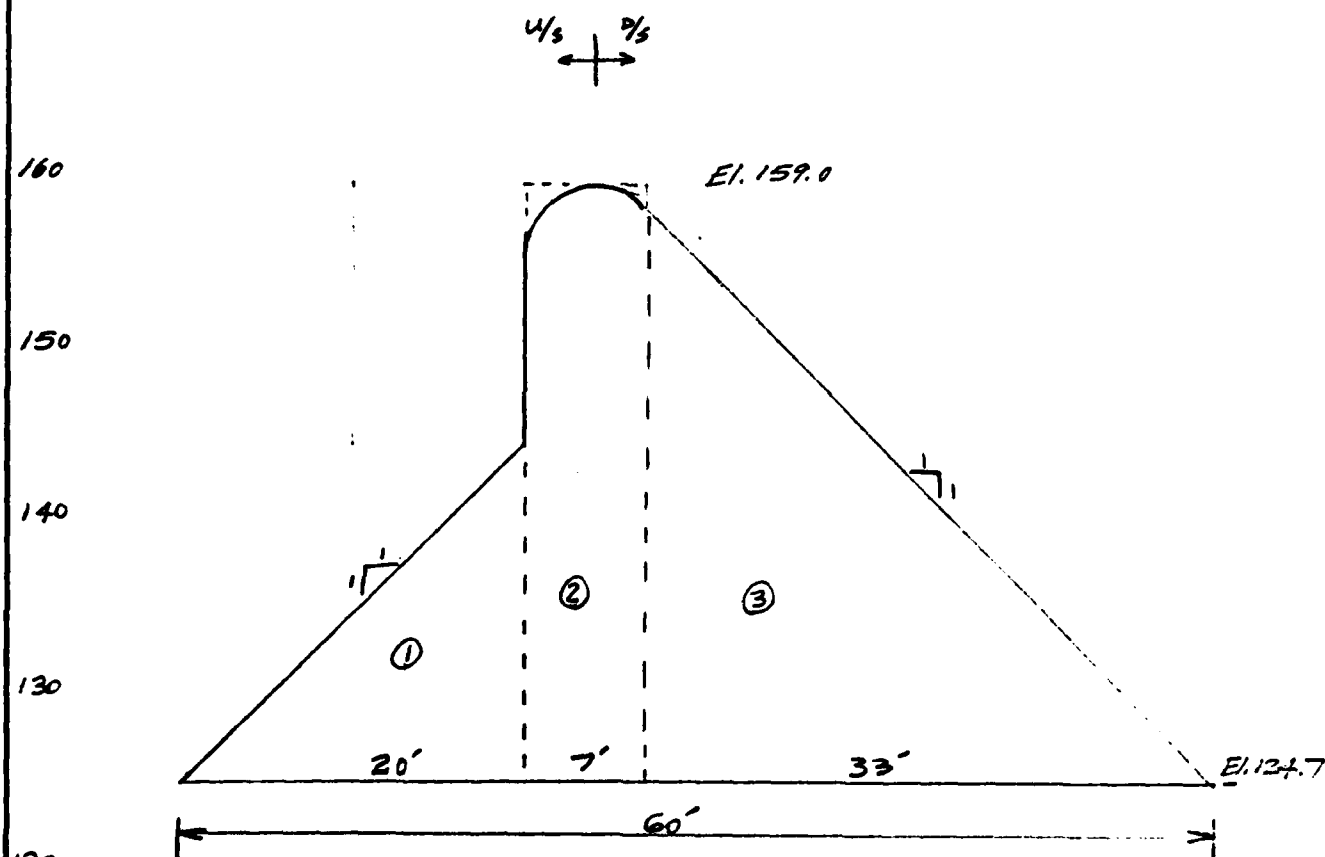
S.O. No. 13855-ARA

Sheet No. 1 of 7

Drawing No. _____

Date June 3, 1931

SPILLWAY CROSS SECTION



Section	Ft^3	$\gamma \frac{k}{Ft^3}$	$W(k)$	Moment Arm	Moment
① $\frac{1}{2}(20)(20) =$	200	0.15	30	$40 + \frac{20}{3}$	1400
② $7'(34.3) =$	240.1	0.15	36.015	36.5	1314.548
③ $\frac{1}{2}(33)^2 =$	544.5	0.15	81.675	$\frac{2}{3}(33)$	1796.35
			147.69		4511.398

Location of Weight Resultant = $\frac{4511.398}{147.69} = 30.55$ Ft from Tie

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009Subject Glenham Dam
Stability Analysis
Overflow SectionComputed by JGU Checked by YD Date June 3, 1981S.O. No. 13552-ARASheet No. 2 of 7

Drawing No. _____

CASE I - NORMAL POOL

Pool = El. 159.0 ft Tailwater @ El. of D/S sill = 128.1 ft

Uplift Force

Reservoir Side = $(159 - 124.7)(0.0625) = 2.144 \text{ ksf}$

Tailwater Side = $(128.1 - 124.7)(0.0625) = 0.213 \text{ ksf}$

Uplift Resultant = $\left(\frac{2.144 + 0.213}{2}\right) 60 = 70.71 \text{ kips}$

Uplift Resultant Location =
$$\frac{(0.213)(60)(\frac{60}{2}) + (2.144 - 0.213)(\frac{1}{2})(60)(60)(\frac{2}{3})}{70.71}$$

= 38.193 Ft. From Toe

Hydrostatic Force

U/S $\frac{1}{2}(159 - 124.7)^2 (0.0625) = 36.765 \text{ kips}$

U/S H.F. Resultant Location $34.3 \frac{\text{ft}}{3} = 11.433 \text{ ft above base}$

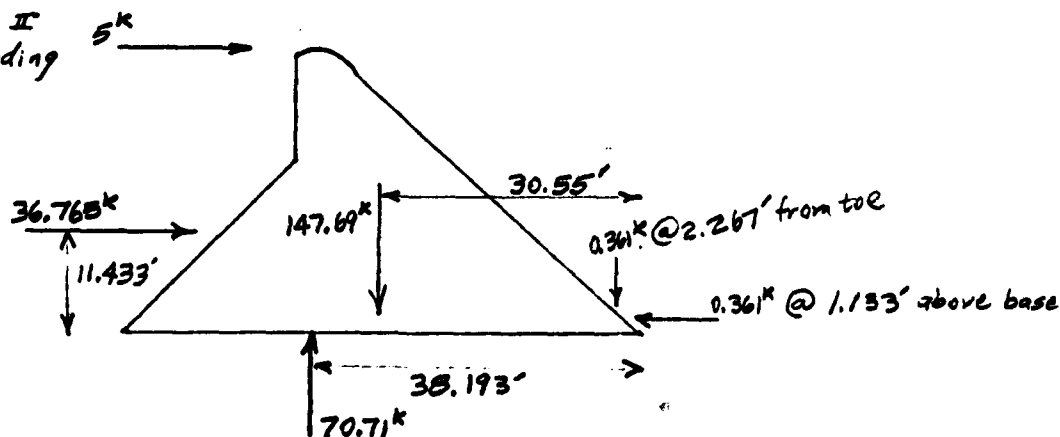
D/S $\frac{1}{2}(128.1 - 124.7)^2 (0.0625) = 0.361 \text{ kips}$

D/S Tailwater Resultant Location = $3.4 \frac{\text{ft}}{3} = 1.133 \text{ ft.}$

Additional Weight Due to Tailwater

$\frac{1}{2}(3.4)^2 (0.0625) = 0.361 \text{ kips}$

Location = $\frac{2}{3}(3.4) = 2.267 \text{ ft from Toe}$

Case I & II Loading DiagramCase II
Ice Loading

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Glenham Dam S.O. No. 13853-ARM
Stability Analysis Sheet No. 3 of 7
Overflow Section Drawing No. _____
Computed by JGU Checked by YDY Date June 3, 1981

Case I

$$\begin{aligned} F.S. \text{ overturning} &= \frac{\Sigma R}{\Sigma D} = \frac{(147.69)(30.55) + (0.361)(2.267) + (0.361)(1.133)}{(36.765)(11.433) + (70.71)(38.193)} \\ &= \frac{4513.157}{3120.961} = \underline{\underline{1.446}} \end{aligned}$$

$$\begin{aligned} F.S. \text{ sliding} &= R/H \text{ where } R = \Sigma V \tan \phi + sA \\ &\text{assume } \phi = 35^\circ \quad s = 2 \text{ ksf} \quad A = 60 \text{ sq. ft} \end{aligned}$$

$$\begin{aligned} R &= (147.69 + 0.361 - 70.71) 0.7 + 2(60) \\ &= 77.341(0.7) + 120 \\ &= 174.139 \end{aligned}$$

$$\Sigma H = 36.765 - 0.361 = 36.404$$

$$F.S. = \frac{174.139}{36.404} = \underline{\underline{4.784}}$$

$$\text{Resultant Location} = \frac{\Sigma M}{\Sigma V} = \frac{4513.157 - 3120.961}{77.341} = \underline{\underline{18.001 \text{ ft from toe}}}$$

Middle $\frac{1}{3}$ = 40 ft to 20 ft. from toe

Case II

$$F.S. \text{ overturning} = \frac{4513.157}{3120.961 + (5)(34.3)} = \frac{4513.157}{3292.461} = \underline{\underline{1.371}}$$

$$F.S. \text{ sliding} = \frac{174.139}{36.404 + 5} = \frac{174.139}{41.404} = \underline{\underline{4.206}}$$

$$\text{Resultant Location} = \frac{4513.157 - 3292.461}{77.341} = \underline{\underline{15.783 \text{ ft from toe}}}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Glenham Dam
Stability Analysis
Overflow Section

Computed by JGU Checked by DDH

S.O. No. 13888-ARA

Sheet No. 4 of 7

Drawing No. _____

Date June 3, 1981

Case III - 1/2 PMF

max reservoir surface = El. 172.4 $H_w = 47.7$ ft

max tailwater surface = El. 142.0 $H_w = 17.3$ ft

Uplift Force

$$4/5 (47.7)(0.0625) = 2.981 \text{ kips/s.f.}$$

$$\text{Tailwater } (17.3)(0.0625) = 1.081 \text{ kips/s.f.}$$

$$\text{Uplift Resultant} = \left(\frac{2.981 + 1.081}{2} \right) 60 = 121.86 \text{ K}$$

$$\begin{aligned} \text{Uplift Resultant Location} &= \frac{(1.081)(60)\left(\frac{60}{2}\right) + (2.981 - 1.081)\frac{1}{2}(60)(60)\frac{2}{3}}{121.86} \\ &= 34.677 \text{ ft. from toe} \end{aligned}$$

Hydrostatic Force

$$4/5 \text{ top of dam} = (172.4 - 159.0)(0.0625) = 0.838 \text{ Ksf}$$

$$\text{base of dam} = (172.4 - 124.7)(0.0625) = 2.981 \text{ Ksf}$$

$$\text{Resultant} = \left(\frac{0.838 + 2.981}{2} \right) (34.3) = 65.496 \text{ K}$$

$$\begin{aligned} 4/5 \text{ Resultant Location} &= \frac{(0.838)(34.3)\left(\frac{34.3}{2}\right) + (2.981 - 0.838)\frac{1}{2}(34.3)\left(\frac{34.3}{3}\right)}{65.496} \\ &= 13.942 \text{ ft. above base} \end{aligned}$$

$$\text{Tailwater } \frac{1}{2}(17.3)^2(0.0625) = 9.353 \text{ K}$$

$$\text{Tailwater Resultant Location} = \frac{17.3}{3} = 5.767 \text{ ft. above base}$$

Additional Weight due to Tailwater



$$\frac{1}{2}(17.3)^2(0.0625) = 9.353 \text{ K}$$

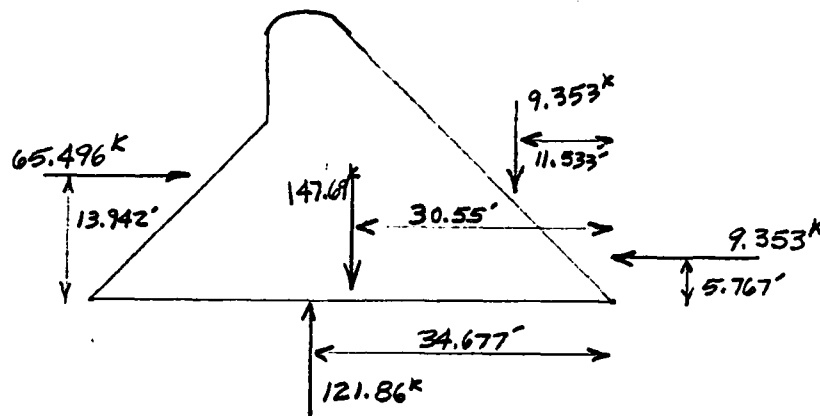
$$\text{Resultant Location} = \frac{2}{3}(17.3) = 11.533 \text{ ft. from toe}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Glenham Dam S.O. No. 13883-ARA
Stability Analysis Sheet No. 5 of 7
Overflow Section Drawing No. _____
Computed by JGU Checked by YDA Date June 3, 1981

Case III Loading Diagram



$$\begin{aligned} F.S. \text{ overturning} &= \frac{(147.69)(30.55) + 9.353(11.533) + 9.353(5.767)}{(121.86)(34.677) + (65.496)(13.942)} \\ &= \frac{4673.736}{5138.884} = \underline{\underline{0.909}} \end{aligned}$$

$$\begin{aligned} F.S. \text{ sliding} &\Rightarrow \phi = 35^\circ \quad s = 2 \text{ ksf} \\ R &= \Sigma V \tan \phi + sA \\ &= (147.69 + 9.353 - 121.86)(0.7) + 2(60) \\ &= (35.183)0.7 + 120 = 144.628 \\ ZH &= 65.496 - 9.353 = 56.143 \end{aligned}$$

$$F.S. = \frac{144.628}{56.143} = \underline{\underline{2.576}}$$

$$\text{RESULTANT LOCATION} = \frac{\Sigma M}{\Sigma V} = \frac{4673.736 - 5138.884}{35.183} = \underline{\underline{-13.221 \text{ ft}}}$$

Note: A negative means the resultant is downstream from the toe

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Glenham Dam
Stability Analysis
Overflow Section

Computed by JGU Checked by MDM

S.O. No. 13883-ARA

Sheet No. 6 of 7

Drawing No. _____

Date June 3, 1981

Case IV - PMF

Max reservoir surface = 176.5 ft. $H_w = 51.8$ ft.

Max tailwater surface = 147.2 ft. $H_w = 22.5$ ft.

Uplift Force

$$\frac{1}{3} (51.8)(0.0625) = 3.238 \text{ ksf}$$

$$\text{Tailwater } (22.5)(0.0625) = 1.406 \text{ ksf}$$

$$\text{Uplift Resultant} = \left(\frac{3.238 + 1.406}{2} \right) 60 = 139.32 \text{ kips}$$

$$\begin{aligned} \text{Uplift Resultant Location} &= \frac{(1.406)(60)\left(\frac{60}{2}\right) + (3.238 - 1.406)\frac{1}{2}(60)(60)\frac{2}{3}}{139.32} \\ &= 33.945 \text{ ft from toe} \end{aligned}$$

Hydrostatic Force

$$\frac{1}{3} \text{ top of dam} = (176.5 - 159.0)(0.0625) = 1.094 \text{ ksf}$$

$$\text{base of dam} = (176.5 - 124.7)(0.0625) = 3.238 \text{ ksf}$$

$$\text{Resultant} = \left(\frac{1.094 + 3.238}{2} \right) (34.3) = 74.294 \text{ k}$$

$$\begin{aligned} \frac{1}{3} \text{ Resultant Location} &= \frac{(1.094)(34.3)\left(\frac{34.3}{2}\right) + (3.238 - 1.094)\frac{1}{2}(34.3)(34.3)\frac{2}{3}}{74.294} \\ &= 14.321 \text{ ft. above base} \end{aligned}$$

$$\text{Tailwater } \frac{1}{2}(22.5)^2 (0.0625) = 15.820 \text{ k}$$

$$\text{Tailwater Resultant Location} = \frac{22.5}{3} = 7.5 \text{ ft above base}$$

Additional Weight due to tailwater

$$\frac{1}{2}(22.5)^2 (0.0625) = 15.820 \text{ k}$$

$$\text{Resultant Location} = \frac{2}{3}(22.5) = 15 \text{ ft. from toe}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Glenham Dam

Stability Analysis
Overflow Section

Computed by JGU

Checked by MDR

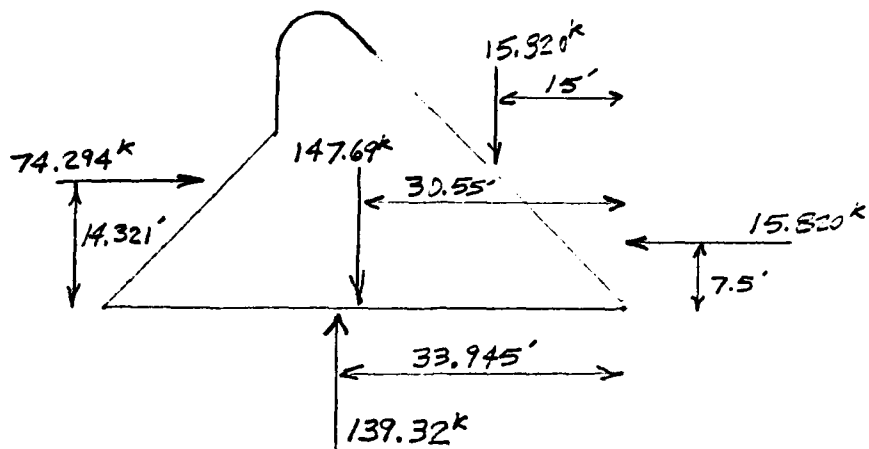
S.O. No. 13888-

Sheet No. 7 of 7

Drawing No. _____

Date June 3, 1961

Case IV Loading Diagram



$$F.S._{\text{overturning}} = \frac{(147.69)(30.55) + (15.820)(15) + 15.820(7.5)}{(74.294)(14.321) + (139.32)(33.945)} = \frac{4367.880}{5793.182} = 0.75$$

$$F.S._{\text{sliding}} \Rightarrow \phi = 35^\circ \quad s = 2 \text{ ksf}$$

$$R = \Sigma V \tan \phi + sA$$

$$= (147.69 + 15.82 - 139.32) \cdot 7 + 2(60)$$

$$= (24.19) \cdot 7 + 120 = 136.933$$

$$\Sigma H = 74.294 - 15.82 = 58.474$$

$$F.S. = \frac{136.933}{58.474} = \underline{\underline{2.342}}$$

$$\text{Resultant Location} = \frac{4867.880 - 5793.182}{24.19} = \underline{\underline{-38.25 \text{ ft}}}$$

Note: Negative means the resultant is downstream from the toe.

ATE
LMED
— 8